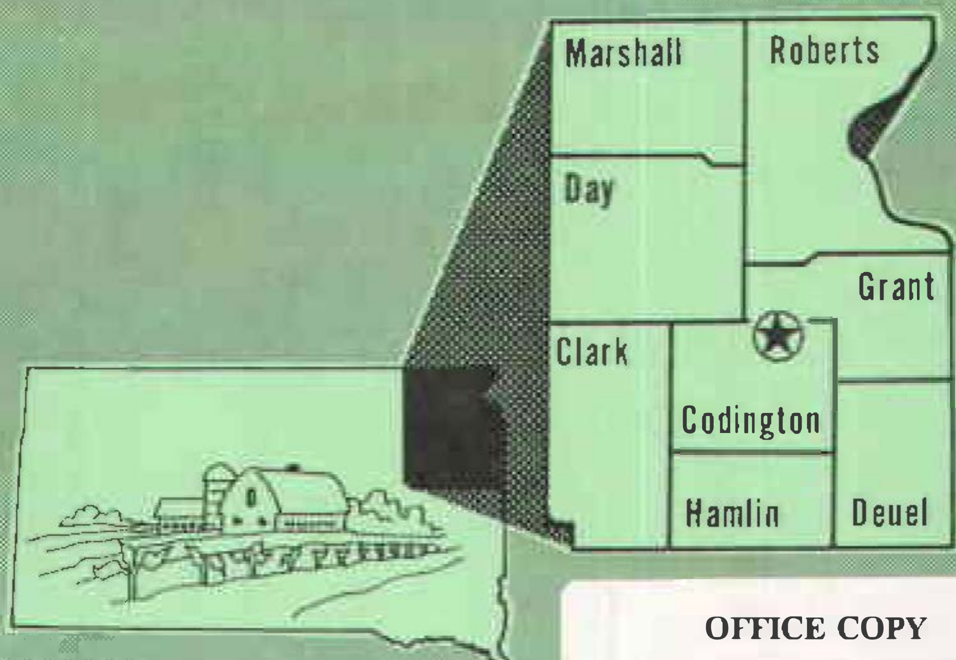
Plant Science Pamphlet No. 66
ANNUAL PROGRESS REPORT

January 1992

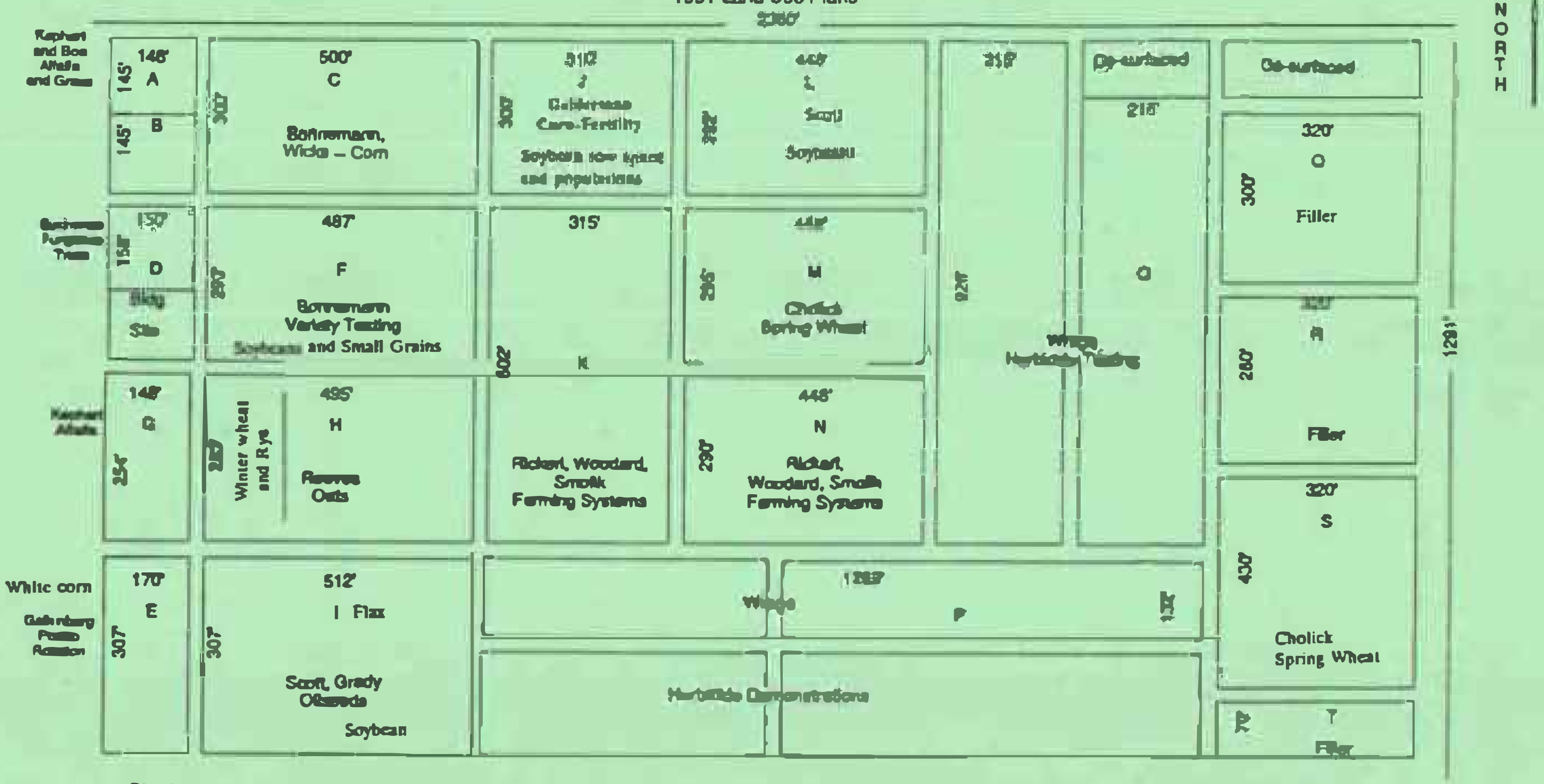
1991 ANNUAL PROGRESS REPORT

Northeast Research Station
Watertown, South Dakota



Plant Science Department
South Dakota State University
Brookings, South Dakota 57007

Northeast Research Station (Watertown)
1991 Land Use Plans



Plot Acreage:

A	0.49	H	3.22	O	9.57
B	0.49	I	3.61	P	8.65
C	3.44	J	2.13	Q	2.20
D	0.54	K	4.35	R	2.06
E	1.20	L	3.00	S	3.16
F	3.28	M	3.03	T	0.51
G	0.86	N	2.98		

Roadways: 25 feet wide
Acreage in farm: 70
Experimental Acreage: 59

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ANNUAL PROGRESS REPORT, 1991
Northeast Research Station, Watertown, South Dakota
J. D. Smolik, Manager

A long-term goal of the Northeast Station Advisory Board and the Agricultural Experiment Station was achieved in 1991 with the construction of a 50' x 100' office/storage building. We wish to thank the South Dakota Crop Improvement Association, who provided funds for the building shell, and the Agricultural Experiment Station for providing a matching amount for completion of the interior. Special thanks to members of the NE Advisory Board for their support of this project, and to Mr. Laird Larson, who served as chairman of the building committee. The new building includes a small office area, a work area/meeting room, handicap-accessible lavatory facilities, showers, and an ample storage/shop area. It has already increased the efficiency and safety of operations at the Station. The building was dedicated at the summer tour with a record level of nearly 500 in attendance. Summer tour topics included herbicide demonstrations, small grain varieties, diseases, and breeding, nitrate soil testing, soybean breeding, farming systems, alfalfa varieties, and pesticide applicator updates. We thank the Area Crop Improvement Associations for serving the evening lunch. The fall tour was also well attended and included discussions of soybean row space studies, millet performance, corn hybrids, forage legumes, late-season weed control, and feeding off-quality small grains. We thank Nick Endres for again supplying wagons for use at the tours. Thanks also to Orrin Korth and family for their assistance in harvest operations.

We entered the 1991 season with rather short soil moisture reserves, but by the end of June we had received more precipitation than we normally receive for an entire season. Growing season precipitation totalled 28.01 inches, 10 inches above the long-term average, and 1991 was the wettest year on record in the 36-year history of the station (Fig. 1). June of 1991 was the wettest month on record (Table 1). The last frost was 3 May and first frost was 26 September.

The abundant moisture resulted in excellent row crop yields, and soybean yields were at record levels. Yields of forage legumes were also at record levels. Unfortunately, the extended period of warm, moist weather in June accompanied heading of the small grain crops, and the weather conditions resulted in severe infection levels of Fusarium Head Scab. Yields of spring wheat and barley were drastically reduced, and in several instances yields obtained were less than those recorded in the 1988 drought year. Fusarium Head Scab is a difficult disease to control, and fortunately it is not normally a severe problem in this area of South Dakota. The fungus that causes the disease is able to survive and reproduce on decaying crop residues, and thus is present in most fields every year. Warm, wet weather between flowering and hard dough can cause severe scab outbreaks. There were some indications that the disease was somewhat more severe under reduced-tillage conditions, which might be expected since the greater amount of surface residue could result in higher inoculum levels of the fungus. It is known that corn residues will increase scab levels, however, scab was severe in many area spring wheat fields even when corn was not the previous crop.

NOTE: Much of the information in this report is based on ongoing studies, and results should therefore be considered tentative. The use of trade names in this publication does not constitute an endorsement of the product by either the Plant Science Department or the Agricultural Experiment Station.

Special thanks to Kathy Reese for her assistance in preparing this report.

1991
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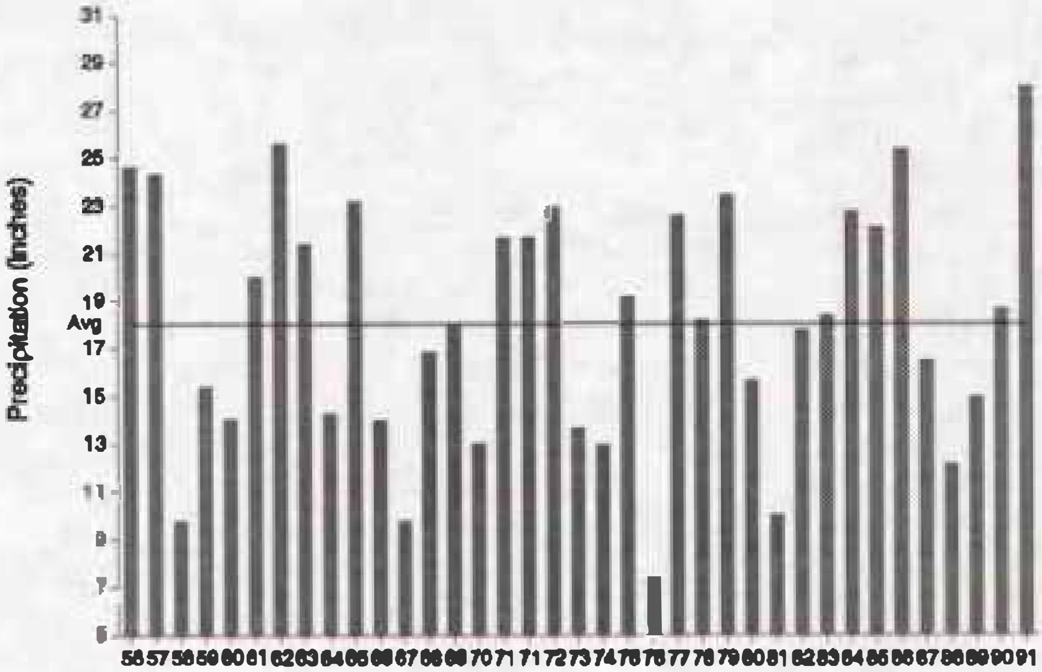
*County Extension Agent

Growing Season Precipitation 1956-1991
N.E. Station and Watertown FAA*

Year	April	May	June	July	Aug.	Sept.	Oct.	Total	Frost-Free Days
				inches					
1956	1.80	2.88	6.56	4.02	6.25	0.70	2.44	24.65	125
1957	4.26	5.98	2.85	0.74	5.26	2.12	3.12	24.33	119
1958	1.41	1.49	2.65	2.68	0.57	0.81	0.18	9.79	116
1959	0.58	3.47	1.91	1.66	4.69	1.10	1.95	15.36	110
1960	1.53	3.84	4.05	0.79	1.03	1.30	1.50	14.04	123
1961	2.16	5.75	4.01	4.62	0.62	1.84	1.00	20.00	138
1962	1.39	5.48	3.98	10.36	1.89	1.39	1.11	25.60	143
1963	1.41	3.54	3.22	5.74	2.51	4.33	0.68	21.43	158
1964	2.39	1.07	3.62	2.01	4.22	0.93	0.04	14.28	92
1965	2.89	6.08	3.66	2.34	2.63	4.33	1.23	23.16	104
1966	1.49	0.77	1.88	2.19	4.59	1.53	1.52	13.97	138
1967	0.92	0.69	4.58	1.05	1.13	1.06	0.35	9.78	129
1968	3.04	2.15	3.18	2.39	1.53	2.56	2.00	16.85	132
1969	1.52	3.44	1.96	4.52	2.48	1.86	2.18	17.96	109
1970	2.00	1.98	2.07	2.29	1.00	1.66	2.01	13.01	148
1971	1.33	1.78	7.61	1.02	2.93	1.46	5.56	21.69	168
1972	1.90	7.73	2.92	6.35	2.57	0.11	1.37	22.95	172
1973	1.14	2.87	1.12	2.05	1.27	3.81	1.39	13.65	183
1974	1.22	3.37	1.45	2.09	3.70	0.22	0.91	12.96	141
1975	4.15	2.18	4.76	1.25	2.89	2.28	1.64	19.15	139
1976	1.10	1.26	1.49	0.51	0.79	1.62	0.57	7.34	144
1977	2.64	2.24	5.78	2.47	2.70	3.67	3.06	22.56	180
1978	3.38	5.15	2.26	2.08	2.43	2.32	0.53	18.15	178
1979	3.14	2.17	5.78	3.10	5.21	0.53	3.50	23.43	162
1980	0.43	3.09	4.97	1.96	3.82	0.72	0.68	15.67	150
1981	0.48	0.99	2.73	2.23	1.20	0.52	1.88	10.03	136
1982	0.35	5.50	1.37	4.05	0.64	2.73	3.11	17.75	175
1983	0.70	1.64	3.43	5.45	3.00	2.86	1.30	18.38	140
1984	2.88	1.66	7.45	1.85	3.09	1.14	4.69	22.76	147
1985	1.93	3.90	2.07	5.21	3.65	3.77	1.59	22.12	167
1986	5.55	4.64	3.62	4.14	3.11	4.19	0.13	25.38	159
1987	0.55	2.03	1.20	4.16	5.64	2.44	0.45	16.47	162
1988	0.59	2.76	0.69	0.86	4.03	2.98	0.22	12.13	144
1989	2.95	1.15	1.74	2.41	4.58	1.56	0.56	14.95	147
1990	1.04	2.26	5.13	3.73	2.58	2.16	1.78	18.68	136
1991	4.01	4.41	10.45	2.69	4.37	1.45	0.63	28.01	146
AVG:	1.95	3.09	3.56	2.97	2.91	1.95	1.58	18.01	143

*1960-1962, 1973-1976, 1978 and 1979 data obtained from Watertown FAA station.



1991 CROP PERFORMANCE TRIALS OF SMALL GRAINS, SOYBEANS AND CORN AT THE NORTHEAST RESEARCH STATION

J. J. Bonnemann

The crop performance testing program included small grains, soybeans and corn in 1991. The small grains under trial were barley, durum, oats, spring wheat, and triticale. Soybean trials included Group O and Group I maturity groups. The corn trials were separated into early and later maturity yield trials based on relative days to maturity information supplied by the participating companies. The arbitrary division was set at earlier or later than 95 days. The proprietary entries included are the choice of the participating companies and included on a fee basis.

The small grain yields were excellent to poor in all trials. May and June temperatures were above normal. This factor combined with high rainfall and humidity caused severe disease damage to susceptible small grain varieties. Soybean yields were excellent to good with a few exceptions. The corn yields were generally good to excellent. The results of the winter wheat and rye trials and the state-wide results of the small grain and soybean trials and more agronomic data are reported in EC 774(rev.) and EC 775(rev.), respectively. The corn results are reported in Circular #253. The publications are available from County Extension offices or from the Bulletin Room, SDSU, Brookings, SD 57007.

Table 2. 1991 Small Grain Trials, Northeast Station, Watertown, SD, CPT

Spring Wheat Variety Name	Yield	Test Weight	Oats Variety Name	Yield	Test Weight
2375	36.0	57.9	Troy	108.0	30.6
Sharp	27.5	57.0	Horicon	98.5	30.7
Prospect	27.1	52.2	Dane	92.7	27.6
Butte 86	27.1	55.0	Settler	92.5	32.5
Guard	25.1	52.1	Don	88.9	32.7
2371	24.3	52.5	Hazel	88.8	31.9
Dalen	23.8	51.3	Newdak	86.2	29.5
Stoa	23.6	53.2	Valley	82.5	30.4
Grandin	23.6	53.3	Premier	80.5	30.9
Amidon	21.1	51.1	Ogle	79.5	27.9
Fjeld	20.7	49.3	Porter	77.9	30.7
Nordic	20.4	51.8	Hamilton	74.5	27.4
Bergen	20.2	50.8	Moore	69.8	27.8
Gus	18.9	50.6	Hytest	67.6	33.8
2369	17.8	52.0	Burnett	65.8	29.7
Celtic	17.6	52.1	Steele	62.9	24.5
Vance	15.6	51.3	Starter	62.2	32.0
Chris	14.4	53.4	Kelly	55.0	29.7
W2501	13.9	44.6			
Telemark	12.8	48.7	Means	81.3	29.8
W2502	11.6	46.5	LSD (.05)	4.8	
Marshall	9.9	49.3	CV - %	3.6	
Means	22.4	52.2			
LSD (.05)	4.2				
CV - %	11.5				

Barley			Durum		
Robust	55.5	40.0	Ward	25.6	53.4
B1602	54.4	37.4	Monroe	22.6	52.3
Azure	54.1	37.8	Vic	21.4	53.8
Stark	53.8	38.7	Fjord	18.9	51.2
Hazen	50.7	36.6	Renville	18.6	50.8
Bowman	50.0	41.1	Sceptre	14.5	50.6
Excel	49.2	36.2	Stockholm	9.5	47.3
B1603	47.8	36.3			
Gallatin	45.2	36.8	Means	18.7	51.3
Morex	42.2	36.9	LSD (.05)	5.3	
			CV - %	16.0	
Means	48.9	37.1			
LSD (.05)	1.8				

Triticale		
Marval	22.4	40.7
Kramer	18.8	40.0
Trical Victoria	12.5	42.0
Means	17.9	40.9
LSD (.05)	3.3	
CV - %	10.6	
CV - %	6.4	

Table 3. 1991 Group O Soybean Performance Trial, CPT, NE Farm, Watertown, SD

Variety Name	Yield B/A	Plant Height	Mature Mo-Day
Sibley (ck)	46.1	33	9/26
Mustang M-1050	45.1	29	9/24
Mustang M-1000	44.1	31	9/22
DeKalb CX096	43.9	30	9/22
Pioneer 9091	43.9	27	9/20
Top Farm 0100	43.3	30	9/22
GCS Badger	43.1	27	9/21
Northrup King S 07-80	42.8	30	9/19
Hillcrest HC091	42.8	31	9/23
Interstate IS546	42.3	32	9/23
Simpson	41.6	27	9/19
Pioneer 9061	41.3	26	9/18
Sands SOI059	40.6	31	9/23
Arrowhead 8450	40.6	32	9/21
Dahlgren KG-62	40.5	28	9/22
Swift	40.3	31	9/18
Star Exp 9108	40.1	28	9/18
Dahlgren KG-60	39.9	25	9/20
Dawson (ck)	39.9	27	9/18
GCS Baker	39.9	29	9/16
Dassel	38.9	30	9/19
Northrup King B095	38.5	30	9/21
Glenwood (ck)	38.1	25	9/16
Evans	35.8	29	9/16
Ozzie	32.7	26	9/16
McCall (ck)	26.9	21	9/ 6
Means	39.9	28	9/20
LSD (.05)	4.8		
CV - %	7.4		

Table 4. 1991 Group I Soybean Performance Trial, CPT, NE Farm, Watertown, SD

Variety Name	Yield B/A	Plant height	Mature Mo-Day
Arrowhead 8500	52.1	35	9/28
Arrowhead 8600	50.3	32	10/ 1
Top Farm 1406	49.6	35	9/27
Mustang M-1150	49.3	33	9/30
Golden Harvest X196	48.8	31	10/ 3
Stine 1220	48.7	31	9/28
Kato	48.6	34	9/26
Mustang M-1140	48.6	34	9/28
ProfiSeed PS1850	48.1	31	10/ 1
Leslie	47.9	33	10/ 2
Diamond SC192	47.6	32	10/ 2
Sibley (ck)	47.3	32	9/27
Pioneer 9162	47.3	29	9/29
DeKalb CX117	47.3	31	9/27
Weber	47.3	38	9/29
Kasota	47.1	30	9/30
Dahlgren C3151	46.1	30	9/30
Sands SOI116	46.0	35	10/ 2
Funks G-3197	45.8	30	10/ 2
Kenwood (ck)	45.5	37	10/ 5
Pioneer 9131	45.4	33	9/27
Arrowhead 8700	45.4	33	9/30
Star Exp 9111	45.2	33	9/27
Golden Harvest H1150	45.2	35	9/29
Sturdy (ck)	45.0	37	10/ 4
Sands SOI166	45.0	32	10/ 2
BSR 101	44.9	36	10/ 3
Bert	44.7	37	10/ 1
Interstate IS9115	44.2	30	10/ 1
Interstate IS622	43.7	31	10/ 2
Pioneer 9111	43.4	27	9/25
Bell (SCN)	41.6	32	10/ 3
Funks G-3100	40.9	30	9/29
Hardin	37.3	35	9/28
Corsoy 79	36.8	41	10/ 5
Dawson (ck)	35.3	28	9/17
Glenwood (ck)	31.7	27	9/15
Means	44.5	33	9/29
LSD (.05)	4.5		
CV - %	6.2		

Table 5. 1991 Corn Performance Trial, Area D2(early), Northeast Farm, Watertown, SD

Brand and Variety	Type and Cross		Yield B/A	Test Weight Lb/B	% Stalk Lodged	Aver. Plants /acre	% Moist	Performance Score
AgriGene AG3860	E	2X	158.8	56.9	1.1	20105	20.6	2
DeKalb DK462	E	2X	156.7	54.8	0.0	19881	19.1	1
Cargill 3637	E	2X	156.1	56.9	2.2	20328	19.6	3
Dahlgren DC440	E	2X	151.5	59.2	1.7	20105	17.9	4
Cargill 3427	E	2X	150.7	58.7	0.0	20216	19.3	5
Northrup King N3624	E	2X	149.8	56.9	0.0	19881	18.8	6
Cargill 2927	E	2X	148.7	60.6	1.7	20105	17.8	7
Asgrow RX406	E	2X	144.3	58.0	1.7	20105	19.5	9
Interstate IS448	E	2X	144.0	58.5	1.1	19993	19.1	8
Golden Harvest H2343	E	2X	143.0	56.3	0.0	18429	20.1	11
Top Farm SX1097A	E	2X	141.6	55.1	0.0	19993	21.5	15
Horizon 4545	E	2X	141.2	62.1	0.6	19658	17.8	10
Top Farm SX1195A	E	2X	140.4	59.1	0.6	19881	19.1	14
AgriGene AG3200	E	2X	140.0	58.7	0.0	20105	18.7	13
DeKalb DK401	E	2X	138.7	57.3	0.0	19099	17.4	12
Garst 8777	E	2X	138.2	53.8	1.1	20105	19.5	17
Funks G-4120	E	2X	137.0	61.7	0.0	19993	18.0	16
Top Farm SX1194	E	2X	136.0	61.7	0.5	20328	18.6	18
Golden Harvest H2295	E	2X	135.9	60.6	1.7	19993	18.8	19
Funks G-4070	E	2X	134.4	58.0	1.1	19769	18.7	20
Pioneer 3787	E	2X	133.5	56.2	0.0	17759	19.1	24
Garst 8851	E	2X	133.2	60.2	0.6	19658	18.6	23
Garst SC 1594	E	2X	132.9	58.6	0.6	18988	18.3	22
Asgrow RX337	E	2X	132.3	61.5	0.0	19546	17.7	21
Interstate IS463	E	2X	131.3	59.0	1.7	19546	19.1	25
Kaystar KX-450	E	2X	129.7	58.3	0.0	20105	18.7	27
Dahlgren D5911	E	2X	129.6	59.5	0.0	19323	18.4	26
Pioneer 3921	E	2X	127.6	61.0	0.6	20105	18.5	28
Funks G-4160	E	2X	125.5	58.8	0.6	18653	18.7	30
Garst 8952	E	2X	124.8	60.8	0.0	20105	18.0	29
Horizon 8095	E	2X	124.2	56.0	0.6	19769	19.3	31
Horizon 3737	E	2X	115.8	62.1	0.0	17201	16.8	32
Pioneer 3917	E	2X	115.1	64.3	0.6	19881	18.3	33
Means			137.7	58.8	0.6	19658	18.8	

LSD(.05) 15.8 CV - 7.0 %

Table 6. 1991 Corn Performance Trial, Area D2(late), Northeast Farm, Watertown, SD

Brand and Variety	Type and Cross	Yield B/A	Test Weight Lb/B	% Stalk Lodged	Aver. Plants/ acre	% Moist	Performance Score
Cargill 4327	M 2X	168.0	58.7	0.0	20216	22.2	1
Cargill 5327	M 2X	159.2	54.7	0.0	20216	22.0	2
Golden Harvest H2390	E 2X	153.7	56.1	0.0	19993	22.1	5
Pioneer 3563	M 2X	153.3	57.1	0.0	20105	21.4	3
Sigco 1799	M 2X	151.6	59.2	0.6	20216	20.0	4
Northrup King N4350	M 2X	149.0	53.6	0.0	19993	20.8	6
DeKalb DK485	E 2X	147.0	56.9	0.0	18876	20.7	7
Interstate IS549	M 2X	146.6	58.8	0.0	19993	21.0	8
Funks G-4299	M 2X	145.0	59.7	0.6	19323	20.5	9
Interstate IS523	M 2X	143.5	58.5	0.0	20105	21.6	11
Top Farm SX1101	M 2X	143.0	58.7	0.6	19769	20.8	10
Interstate IS531	M 2X	141.9	57.1	0.6	19881	21.1	12
Asgrow RX469	M 2X	141.4	59.1	0.0	20105	21.2	13
Dahlgren DC494	E 2X	1411.1	55.6	0.0	19769	21.3	14
Top Farm SX1101A	M 2X	140.6	56.7	0.0	19881	21.5	15
Northrup King N4428	M 2X	136.3	56.9	0.0	19099	21.7	16
Funks 2078X	M 2X	131.1	57.0	0.0	19658	20.8	17
Dahlgren D5999	M 2X	129.1	58.9	0.0	19658	20.3	18
Sigco 1099	M 2X	127.7	56.6	0.0	19658	20.7	19
Means		144.7	57.4	0.2	19817	21.0	

LSD(.05) 15.8 CV 7.0 %

SPRING WHEAT BREEDING

B. G. Farber and F. A. Cholick

The studies conducted at the Northeast Farm in 1991 can be divided into two general categories: evaluation of experimental lines and purification/increase of experimental lines. All experiments were planted on April 25, 1991, fertilized for a 60 bu/A yield goal and harvested on August 12, 1991. During the evaluation step of variety development, it is extremely important that one or more locations provide an estimate of yield potential. Traditionally, the spring wheat breeding project has used the Northeast Farm as a location to provide this essential information. Environmental conditions at the farm generally result in higher yields due to adequate moisture and lower temperatures during plant development when compared to most areas of the state where spring wheat is grown. In 1990, three test sites including the Northeast Farm, provided data on yield potential. However, in 1991, the average yield at the Northeast Farm was 21 bu/A or nearly one-third of the 1990 yields. The primary factors causing reduced yields were two diseases, Head Scab and Bacterial Leaf Blight, and temperatures averaging more than six degrees warmer than normal for the period May 1 through June 15. These high temperatures adversely affected two of the major components of yield, tiller number and head size, thereby reducing the yield potential. Later in the season, the two diseases reduced the potential even further. Top yielding check varieties across nurseries were Butte 86, Sharp, 2375 and Guard.

In the advanced yield trial, 11 experimental lines yielded equal to or superior to the top yielding check variety. Two of the 11 lines exceeded the yield of the best check with the highest yield being 29.3 bu/A for the experimental SD 3116. In the preliminary yield trial (PYT), 11 experimental lines exceeded the yield of the top check. The PYT is made up of new lines which are being yield tested for the first time. In 1991, the PYT consisted of material donated by Pioneer International. As a general observation, the Pioneer material is somewhat shorter and later maturing when compared to material developed by the SDSU spring wheat breeding project. An additional 400 experimental lines from Pioneer were also evaluated at the Northeast Farm and in Brookings. The top performing lines in these studies will be advanced to the preliminary yield trials in 1992.

Day County. The breeding project has had a test location in Day County near Pierpont for ten years, in cooperation with Dean Johnson. Two yield trials planted here in 1991 were 1) the Advanced Yield Trial (AYT) and 2) the Uniform Regional Durum Nursery. These experiments were seeded on April 9 and harvested on August 5. The average yield for the bread wheat trial was 39 bu/A while the durum trial averaged 33 bu/A. As at the Northeast Farm, Head Scab was a major factor affecting grain yield. The average yields of the bread wheat and durums illustrate the greater susceptibility of the durums to this disease.

The top check varieties in the bread wheat trials were Butte 86 and 2375. In the advanced yield trial, 7 experimental lines equalled or exceeded the yield of the best check. The top yielding line was SD 3105 which yielded 47.0 bu/A. In the durum trial, the top yielding checks were Rugby, Ward and Monroe. There were several experimental durum lines (developed by the breeding program at North Dakota State University) in the top yielding group. Among these high yielding experimental lines were four semidwarfs with three of these lines maturing only one day later than Monroe, the early check in the trial.

EFFECTS OF HERBICIDES AND APPLICATION RATES AND TIMING ON SPRING WHEAT HEIGHT, YIELD AND QUALITY

C. Langner, F. Cholick, and L. Wrage

The objectives of this study are: 1) determine the effect of selected herbicides on spring wheat yield and seed quality using different herbicide rates and application stages and 2) determine how herbicides affect yield and seed quality from heads produced on main stems or tillers. The five herbicides used were Harmony X, Banvel SGF, 2,4-D Amine, Tiller, and Hoelon; each applied at two rates, recommended and double the recommended rate. The three stages of application were 3-leaf, 6-leaf, and early boot. The experimental design was a randomized complete block with 4 replications. Plot size was 7 by 35 feet. Butte HRS wheat was seeded on April 19, 1991 at 88 pounds per acre. Plots were sprayed with a 'pressurized bicycle plot sprayer' with a 20 gpa output at 40 psi. Both rates were applied at each leaf stage. Dates of application were: 3-leaf (May 13), 6-leaf (May 30), and early boot (June 14). One row, a meter long, was measured and marked in each plot. Main stems in the marked area were tagged at the 5-leaf stage. The tagged main stems and tillers were clipped at ground level and measured at harvest. Heads from main stems and tillers were removed for further evaluations. Each plot was then harvested for yield. This was first year data from a two-year study; therefore conclusions will be developed following the 1992 season. Information on seed quality was incomplete at the time this report was prepared.

There was a significant difference between single rate and double rate over herbicide treatments. The double rate averaged 2 bushel less yield than the single rate.

	Growth Stage at Herbicide Application								
	3-Leaf	3-Leaf	3-Leaf	6-Leaf	6-Leaf	6-Leaf	Early	Boot Stage	
Treatment	Main Stem	Tiller	Yield	Main Stem	Tiller	Yield	Main Stem	Tiller	Yield
	in	in	bu/ac	in	in	bu/ac			
Amine 2,4-D	28.01	27.31	28.14	28.79	28.2	29.84	27.95	27.12	24.43
Banvel SGF	28.2	27.06	30.66	27.65	27.22	27.8	27.61	26.82	24.78
Harmony X	28.74	27.85	30.13	27.75	27.17	29.55	28.54	26.97	28.67
Hoelon	28.94	27.76	29.48	28.35	27.36	29.36	27.71	27.31	26.53
Tiller	26.38	26.62	26.02	26.38	27.61	26.91	23.57	24.95	21.97

CHECK-Main	29.17 in	FLSD @ .05	Main	1.611
CHECK-Tiller	27.91 in	FLSD @ .05	Tiller	1.58
CHECK-Yield	31.1 bu	FLSD @ .05	Yield	2.927

OAT RESEARCH

Dale Reeves and Lon Hall

The preliminary herbicide screening test is a cooperative effort with the oat project and the extension weed staff to screen established varieties and promising lines for herbicide injury. Recommended and doubled rates were applied to four varieties or lines at the 3-4 leaf stage. Results indicate MCPA amine, Bronate, and the low rate of MCPA+Dicamba caused the least injury; however, this may change with the variety, location, year, or stage of plant development. Generally, MCPA amine caused the least amount of injury. Other data has shown plants are more sensitive to Bronate and Dicamba applied at the 6-7 leaf stage. Herbicide injury varies with environmental conditions, therefore several location-years are needed to show overall effects and interactions with variety, herbicide, and environment.

The uniform midseason nursery has 35 lines, which are being considered for release, from several locations in the United States. The breeding nurseries consist of lines selected for this area. A total of 1079 yield plots were tested overall. A nursery comprised of 40 selections out of Troy was also grown. These selections have a range of maturity earlier than or equal to Troy and, based on one years data, show an increase in yield and test weight. The Mississippi Valley Regional Barley trial was grown here as well.

Herbicide Treatment		N.E. Station		3 Location Avg		Yield (% of Check)	
Herbicide	Rate (ai/a)	Yield (bu/a)	TWT (lb/b)	Yield (bu/a)	TWT (lb/b)	N.E. Station %	3 Loc Avg %
Check		85.2	31.9	83.1	31.7	100	100
MCPA am	.5	85.5	33.4*	84.0	32.1	100	101
MCPA am	1.0	85.7	34.1*	83.9	32.1	101	101
2,4-D am	.5	74.4*	32.5	77.9	32.0	87	94
2,4-D am	1.0	63.4*	31.9	66.9	31.3	75	81
Bronate	.75	86.5	32.4	83.0	31.5	102	100
Bronate	1.5	86.0	33.7*	83.9	31.9	101	101
Dicamba + MCPA am	.125+.2	82.8	32.3	83.3	31.2	97	100
Dicamba + MCPA am	.25 + .5	79.1*	31.3	78.6	30.8	93	95

*$LSD_{.05}$ 3.0 .9

All comparisons are made with the check.

1991 FLAX BREEDING

Kathleen Grady

A yield trial of named flax varieties and experimental lines from SD, ND and Canada was grown at the Northeast Research Station and two other locations in 1991. The purpose of the trial was to provide performance data on released flax varieties to farmer/growers and compare performance of experimental lines to established checks in order to identify possible new varieties.

In 1991, 22 experimental lines from the SDSU flax breeding program were tested against 17 named varieties (checks) and 4 experimental lines from ND and Canada. The trial was seeded on May 11, 1991 in a randomized complete block design with 3 replications. Growing conditions were generally good throughout the season. Yield and height data on the 43 entries in the test are presented in Table 7.

The overall mean yield across varieties was 20.4 bu/acre. The highest yielding check variety was NorMan, which averaged 23.7 bu/acre. CI 3306 was the highest yielding experimental line, with 24.9 bu/acre.

Table 7. Data on flax varieties and experimental lines grown at the Watertown NE Research Station in 1991.

Variety	Origin - Year	Seed Yield (bu/A)	Rank	Plant Height (cm)
Clark	SD-83	15.5	41-42	58
Culbert 79	SD-79	15.5	41-42	60
Day	SD-90	21.1	18-19	56
Dufferin	CAN-75	22.6*	10	67
Flanders	CAN-90	23.3*	7	64
Flor	ND-81	19.2	29-30	55
Linott	CAN-66	19.7	26	54
Linton	ND-085	19.8	25	57
McGregor	CAN-82	23.0*	8	66
Neche	ND-88	14.9	43	61
NorMan	CAN-84	23.7*	5	72
Omega	ND-90	20.5	22	58
Prompt	SD-89	20.0	23-24	54
Rahab	SD-85	20.9	20-21	59
Somme	CAN-90	17.8	36-37	61
Verne	MN-87	17.8	36-37	59

Table 7. (cont.)

Variety	Origin - Year	Seed Yield (bu/A)	Rank	Plant Height (cm)
Vimy	CAN-86	17.76	38	60
CI 3270	CAN-exp	24.3*	3	56
CI 3281	ND-exp	15.7	40	63
CI 3283	ND-exp	22.3*	12	67
CI 3285	ND-exp	23.4*	6	66
CI 3296	SD-exp	18.4	33-34	59
CI 3297	SD-exp	22.7*	9	59
CI 3304	SD-exp	24.1*	4	61
CI 3305	SD-exp	21.2	18-19	58
CI 3306	SD-exp	24.9*	1	61
CI 3307	SD-exp	22.1*	13-14	59
CI 3308	SD-exp	20.9	20-21	57
SD88B58	SD-exp	20.0	23-24	54
SD88C55	SD-exp	19.6	27	56
SD88C944	SD-exp	21.4*	17	64
SD88D61	SD-exp	21.5*	16	58
SD88E54	SD-exp	19.2	29-30	58
SD88F55	SD-exp	22.1*	13-14	60
SD88E23	SD-exp	19.4	28	56
SD88E27	SD-exp	18.4	33-34	53
SD88E59	SD-exp	17.4	39	58
SD88F19	SD-exp	17.9	35	57
SD88F51	SD-exp	22.4*	11	66
SD88F52	SD-exp	24.7*	2	64
SD88F53	SD-exp	19.0	31	55
SD88F54	SD-exp	22.0*	15	56
SD88F58	SD-exp	18.7	32	56
Test mean		20.4		59
$LSD_{.05}$		3.5		6
C.V.		10.6		5.8

*Indicates a variety that was in the top-yielding group based on the LSD.

SEED MILLET STUDY

J. Smolik, L. Evjen and A. Heuer

Objectives: Measure yield of four seed millet varieties.

Methods: Plots were planted 26 June, and all varieties were seeded at 16 lb/A. Plots were 21' wide and 135' long. An 8-foot wide swath from the center area of each plot was harvested for yield determination. Each entry was replicated twice in a randomized complete block design.

Results: A considerable amount of lodging was noted in both Dawn and Min-Son. The highest yielding variety was Rise, however, none of the yield differences were statistically significant (Table 8).

Table 8. Yield of four millet varieties, NE Station, 1991.

Entry	Yield (Bu/A)
Dawn	34.9[a]
Min-Son	35.9
Cerise	38.0
Rise	42.6

[a]Average of two replications, yield differences were non-significant.

SOYBEAN RESEARCH

Roy A. Scott

We tested 300 soybean breeding lines in maturity groups 0 and I in nine different experiments. Plots were planted on 20 May, 1991. Plots were 20 feet long in 30-inch rows. Four-row plots were used, but to eliminate border effects only the center two rows were harvested for yield. We recorded data for plant height, lodging, and maturity during the season. After harvest we recorded data for yield, seed quality, and seed size in grams/100 seeds.

Results

Most group I lines were not fully mature before the killing frost on 17 september. However, all lines were mature enough to produce acceptable yield information and good seed quality. Average seed quality ranged from 2-3 using a rating scale of 1-5, where 1 is the best, and 5 is the worst. Average yield at Watertown was slightly lower than our Brookings tests. The experimental lines performed well, compared to the checks. Some lines outyielded the checks significantly, and will be retested in 1992.

1991 POTATO ROTATION STUDY

D. J. Gallenberg and L. Evjen

The basic objective of this long-term study has been to monitor disease pressure and yield in potatoes planted in a particular crop rotation sequence. Potato plots were established in an area that has been in a potato-spring wheat-corn rotation since 1986. The varieties Kennebec and Red Pontiac were planted on May 21 in 40 inch rows with approximately 12 inches between seed pieces. Observations of plants during the season and of tubers at harvest indicated relatively low disease pressure. In the past, Rhizoctonia, Fusarium and other tuber problems have been observed at harvest although foliar disease pressure has been consistently low.

Plots were harvested on September 20 and total tuber yields taken. Mean converted yields were 108 cwt/A for Kennebec and 124 cwt/A for Red Pontiac. These yields were lower than in 1990 when the same varieties averaged 155 and 141 cwt/A, respectively. The variety Kennebec was used in the study in each of the six seasons. Yields during this period were: 1986 - 224 cwt/A; 1987 - 223 cwt/A; 1988 - 76 cwt/A; 1989 - 121 cwt/A; 1990 - 155 cwt/A; 1991 - 108 cwt/A. Disease pressure did not appear to be a significant factor in overall yields although tuber quality was affected in some seasons. Weather was undoubtedly the primary factor in determining yields in these plots over the six year period.

Future studies will examine the effects of changes in the rotation (length of rotation and crops used) and other cultural practices on specific pathogen populations and disease development in potato.

YIELD TRIALS OF OSMOTIC ADJUSTMENT POPULATIONS IN CORN

James Wassom

Osmotic adjustment is a trait of corn that allows it to compensate for drought conditions. Although corn can be bred for drought conditions, drought tolerant varities tend to be low yielding in normal moisture conditions when compared to other varieties. Corn varieties with high osmotic adjustment may be able to tolerate drought while retaining the ability to yield well in normal moisture conditions.

We have developed 6 open-pollinated populations of corn by selecting for either high or low osmotic adjustment and then allowing random mating of the selected plants. Populations with low osmotic adjustment should yield less than high osmotic adjustment, if drought conditions prevail. The 6 populations, as well as the original populations from which they were selected, were compared in a yield trial at the Northeast experiment station. We found no significant differences in yield between the populations. The lack of differences is probably due to the abundant rainfall during the grain-fill period -there would be little expression of the osmotic adjustment trait under such conditions.

BREEDING AND DEVELOPING DROUGHT TOLERANT MAIZE POPULATIONS

G. Sosa and Z.W. Wicks

This study was undertaken to look at the effect of moisture stress and non-stress on three recurrent selection schemes in corn. The original population in this study is a synthetic made up of commercial hybrids that show some degree of drought resistance. In 1984, S_0 plants from the original population were selfed and topcrossed on CMI05 inbred tester. The following year, S_1's progenies were grown in a drought stress environment, and topcrosses were grown in a non-stress environment. The mean yields were ranked from best to lowest yielding, and four populations were resynthesized using remanent S_1 seed. High S_1 population was resynthesized based on the highest yielding fraction of the S_1 yield test in the stress environment. The high TC population was resynthesized based on the highest yielding fraction of the topcross yield trial in the non-stress environment. A high aggregate population was resynthesized based on the highest combined rank index of the S_1 yield in the stress environment with its topcross yield in the non-stress environment. A low aggregate population was resynthesized based on the lowest combined rank index. In 1987, the same procedure was followed using the high aggregate population as source of S1's and topcrosses and four new populations were resynthesized. In 1991, these eight populations, along with the original population were grown in 15 locations with different degrees of moisture stress. Two of these yield trials were planted at the Northeast Research Station at Watertown, South Dakota. The experimental design was an RCB with three replications and a plant population of 48000 plant/ha. Table 9 shows the performance of the different populations.

Table 9. Means of grain yield of original and selected populations evaluated during 1991.

POPULATION	15 LOCATIONS YIELD* (kg/ha)	RANK	WATERTOWN(1) YIELD (kg/ha)	RANK	WATERTOWN(2) YIELD (kg/ha)	RANK
ORIGINAL	5215.9	3	7465.0	2	6153.1	4
HIGH AGG C1	4928.9	7	6233.3	6	4824.0	8
HIGH TC C1	5327.4	2	6849.2	3	6911.0	2
HIGH S1 C1	5111.7	4	6296.1	5	6211.2	3
LOW AGG C1	4670.8	9	6160.1	7	5841.8	6
HIGH AGG C2	5639.9	1	7749.2	1	7615.6	1
HIGH TC C2	5028.4	6	6323.7	4	4739.8	8
HIGH S1 C2	5061.9	5	6296.1	8	5542.7	9
LOW AGG C2	4912.3	8	6148.0	9	5856.0	5
MEAN	5317.6		6535.8		6115.9	
LSD (0.05)	315.7		1629.1		1137.3	

* at 15.5% moisture.

ALFALFA CULTIVAR YIELD TEST

E.K. Twidwell, K.D. Kephart, and R. Bortnem

Two alfalfa cultivar yield experiments were conducted at the NE station during 1991. These tests were conducted to determine yield performance of various alfalfa cultivars and experimental lines when grown in NE South Dakota.

Four harvests were obtained from the study planted in 1988. Total seasonal yields ranged from 5.23 to 7.78 T/A with some significant differences among the cultivars detected (Table 10). Above normal precipitation throughout the growing season permitted one more harvest than is usually obtained at the NE station. Average yields obtained in 1991 were double those obtained in 1989 and 1990. Three-year average yields ranged from 3.72 T/A for 'Premier' alfalfa to 5.15 T/A for '5262'; significant differences among the 28 cultivars were present. One reason for yield differences among cultivars may be due to plant mortality that occurred during the winter of 1989-90. Results from visual ratings performed in April 1990 indicated that there were significant differences in winter damage among the cultivars. These differences in winter damage translate into significant cultivar differences for yield in 1990 and also probably in 1991. It is interesting to note that most of the cultivars that yielded relatively low in 1990 remained at that level in 1991. Results from the 1988 study are particularly valuable to producers concerned about selecting cultivars that are persistent and high yielding under adverse winter conditions. Conditions that were present during the winter of 1989-90 are not expected to be present very often. Information obtained during severe winters indicate that some cultivars tolerate these conditions better than others.

Another experiment was planted in 1990 consisting of 36 cultivars. Four cuttings were obtained during 1991 and some significant yield differences were found (Table 11). Average total yield in 1991 was 7.19 T/A, which is the highest average yield reported at this station in several years. The fall soil moisture reserves appeared to be adequate and if normal precipitation is received during the winter and spring it is hoped that this test will continue to be highly productive in 1992.

Table 10. Forage yield of 28 alfalfa cultivars planted April 28, 1988 at the Northeastern Research Station, Watertown, South Dakota.

Cultivar	1988 1-Cut Total	1989 3-Cut Total	1990 3-Cut Total	1991 Cut 1 6/10	1991 Cut 2 7/10	1991 Cut 3 8/12	1991 Cut 4 10/1	1991 4-Cut Total	3 Year Avg.[a]	Relative Performance[b]
	tons DM / acre									-- % --
5262	0.52	3.87	3.81	3.51	1.45	1.45	1.38	7.78	5.15	118
526	0.56	3.66	3.94	3.47	1.35	1.48	1.36	7.65	5.08	116
Big 10	0.76	4.45	3.71	3.25	1.09	1.24	1.15	6.73	4.96	113
Vernal	0.77	4.00	3.87	3.21	1.28	1.28	1.23	6.99	4.95	113
MTO N82[c]	0.54	3.73	4.33	2.99	1.09	1.06	0.70	5.84	4.63	106
86639[c]	0.53	3.54	3.63	3.23	1.18	1.17	1.14	6.71	4.63	106
120	0.71	3.81	3.45	3.09	1.01	1.29	1.09	6.47	4.58	105
5432	0.49	3.91	3.11	2.95	1.24	1.25	1.29	6.72	4.58	105
AP 8620[c]	0.67	3.86	3.29	2.84	1.13	1.32	1.12	6.40	4.51	103
AP 8631[c]	0.55	3.84	3.13	2.80	1.16	1.30	1.17	6.42	4.46	102
Magnum +	0.52	3.92	3.21	2.76	1.04	1.25	1.15	6.20	4.44	101
Dart	0.54	3.55	3.10	3.14	1.06	1.25	1.22	6.66	4.44	101
Arrow	0.57	3.94	3.09	2.94	1.03	1.18	1.13	6.27	4.43	101
SX 424	0.62	3.75	3.00	2.85	1.01	1.27	1.20	6.33	4.36	100
DK-125	0.67	4.12	2.95	2.58	0.98	1.19	1.16	5.91	4.33	99
FSRC 87M1[c]	0.67	3.60	3.01	2.84	1.06	1.26	1.14	6.30	4.30	98
Magnum III	0.57	4.00	3.04	2.52	1.01	1.19	1.14	5.87	4.30	98
FSRC 87N3[c]	0.57	3.86	2.98	2.69	1.02	1.23	1.11	6.06	4.30	98
Vector	0.62	4.06	2.83	2.50	1.04	1.13	1.08	5.74	4.21	96
FSRC 87N1[c]	0.70	3.88	3.00	2.55	0.94	1.16	1.10	5.75	4.21	96
Chief	0.58	4.15	2.64	2.79	0.84	1.03	1.05	5.70	4.17	95
Sure	0.61	3.81	2.83	2.50	0.87	1.17	1.05	5.59	4.08	93
WL 225	0.47	3.41	2.79	2.66	1.00	1.19	1.12	5.98	4.06	93
SX 217	0.60	3.39	2.76	2.53	0.97	1.18	1.11	5.80	3.98	91
Kingstar	0.58	3.53	2.81	2.50	0.86	1.19	0.99	5.54	3.96	90
WL 320	0.53	3.62	2.55	2.48	0.90	1.19	1.08	5.64	3.94	90
Cimarron	0.67	3.56	2.71	2.28	0.91	1.16	1.19	5.54	3.94	90
Premier		0.57	3.46	2.48	2.31	0.87	1.09	0.97	5.23	3.72 85
AVERAGE		0.60	3.80	3.15	2.81	1.08	1.22	1.13	6.21	4.36
Maturity[d]				4.6	4.1	4.3	4.7			
LSD(0.05)[e]	NS	NS	0.44	0.45	0.34	0.34	0.20	0.75	0.47	

[a] Three year average based on post-establishment year yields, 1989, 1990, and 1991.
[b] % Relative Performance = ratio of cultivar 3-yr average to 3-yr average of all cultivars.
[c] Experimental line, not currently marketed.
[d] Average harvest maturity. Value based on Kalu and Fick (1983) mean-stage-by-count index.
[e] NS = Means among cultivars not significantly different at the 0.05 level of probability.

Table 11. Forage yield of 36 alfalfa cultivars planted May 4, 1990 at the Northeastern Research Station, Watertown, South Dakota.

Cultivar	1990 Cut 1 7/27	1991 Cut 1 6/10	1991 Cut 2 7/10	1991 Cut 3 8/12	1991 Cut 4 10/1	1991 4-Cut Total	Relative Performance[a]
	-----------------	tons DM / acre			-----------------		-- % --
VS-888[b]	1.66	3.73	1.35	1.50	1.35	7.71	107
Multi-plier	1.67	3.54	1.32	1.42	1.43	7.68	107
Centurion	1.59	3.51	1.31	1.42	1.36	7.60	106
Garst 630	1.52	3.40	1.32	1.48	1.36	7.56	105
Dawn	1.56	3.33	1.27	1.48	1.46	7.54	105
G-2833	1.59	3.51	1.29	1.39	1.31	7.50	104
VIP	1.66	3.38	1.28	1.43	1.39	7.47	104
G-2841	1.63	3.50	1.29	1.42	1.24	7.44	104
H 174[b]	1.48	3.15	1.33	1.51	1.45	7.44	103
DK-122	1.59	3.32	1.38	1.42	1.31	7.42	103
MultiKing 1	1.64	3.37	1.28	1.39	1.36	7.40	103
5364	1.58	3.41	1.30	1.40	1.28	7.39	103
Crown II	1.63	3.42	1.26	1.37	1.29	7.33	102
8837N[b]	1.53	3.26	1.28	1.41	1.37	7.33	102
5262	1.49	3.28	1.32	1.41	1.29	7.30	101
SX 217	1.58	3.09	1.34	1.48	1.38	7.29	101
Garst 645	1.65	3.20	1.30	1.42	1.32	7.24	101
8941N[b]	1.57	3.31	1.28	1.35	1.30	7.24	101
WL 225	1.52	3.23	1.31	1.39	1.31	7.23	101
120	1.54	3.50	1.23	1.34	1.17	7.23	101
Baker	1.58	3.50	1.22	1.24	1.26	7.22	100
Perry	1.55	3.33	1.23	1.35	1.30	7.20	100
Allegiance	1.47	3.17	1.42	1.40	1.19	7.18	100
Saranac AR	1.42	3.25	1.25	1.39	1.27	7.16	100
Aggressor	1.46	3.14	1.25	1.43	1.31	7.13	99
MN GRN-14[b]	1.42	3.21	1.34	1.40	1.17	7.11	99
H 154[b]	1.55	2.84	1.32	1.48	1.45	7.09	99
Wrangler	1.53	3.33	1.26	1.26	1.20	7.04	98
8832N[b]	1.49	2.99	1.30	1.38	1.35	7.02	98
WL 317	1.45	3.13	1.27	1.40	1.20	6.99	97
Flint	1.63	3.15	1.22	1.31	1.25	6.92	96
Vernal	1.54	3.29	1.21	1.21	1.07	6.77	94
SDHL1[b]	1.51	3.14	1.22	1.20	1.07	6.63	92
SDHS6[b]	1.63	3.37	1.14	1.10	0.94	6.55	91
NTO S82[b]	1.50	3.18	1.12	1.15	0.96	6.40	89
AFYF 88[b]	1.59	3.20	0.97	0.99	0.79	5.95	83
AVERAGE		1.56	3.30	1.27	1.36	1.26	7.19
Maturity[c]	4.1	4.7	4.0	3.6	2.9		
LSD(0.05)[d]	NS	0.28	0.13	0.13	0.23	0.57	

[a] % Relative Performance = ratio of cultivar 1991 yield to 1991 yield of all cultivars.
[b] Experimental line, not currently marketed.
[c] Average harvest maturity. Value based on Kalu and Fick (1983) mean-stage-by-count index.
[d] NS = Means among cultivars not significantly different at the 0.05 level of probability.

THE USE OF SOIL TESTS TO PREDICT FERTILIZER NITROGEN NEEDS OF CORN

R. Gelderman, S. Drymalski, and L. Evjen

Introduction

Approximately 50% of the total fertilizer nitrogen applied in South Dakota is used on corn. The need for efficient and profitable nitrogen recommendations for corn is apparent. The best guide available for recommending fertilizer is a soil test. Soil tests need to be correlated to field response data such as reported here.

The objective of this study is to determine the relationship of the nitrate-nitrogen soil test to yield response of corn from adding nitrogen fertilizer.

Methods

The study was located on the north side of the Watertown Station on a Brookings soil. These soils are deep, silty clay loam loess over glacial till. Results of the soil tests from samples taken in the spring of 1991 (at planting) are shown in Table 12.

Table 12. Spring soil test results of nitrogen corn studies, Watertown Station, 1991.

NO_3-N					
0-24"	0-48"	O.M.	P	K	pH
lb/acre		%	lb/acre		
36	124	3.8	23	290	6.3

The soil tests for nitrate-nitrogen indicated moderate levels of nitrogen in the top two feet. These levels are not unusual considering soybean (35 bu/acre) was the previous crop. Approximately 88 lbs/acre of available N was located in the two to four foot depth. This is higher than the 30 lb/acre average usually found at this depth. Soil moisture at planting was considered below normal.

Phosphorus is considered medium and additional phosphorus was applied with the planter to eliminate this as a limiting nutrient variable. Potassium is considered high here. The pH is slightly acid.

The previous crop was soybeans. The area was disked before planting Pioneer 3732 on May 10, 1991 at a population of about 22,000 plants per acre. The nitrogen fertilizer treatments were spread on the soil surface as ammonium nitrate eleven days after planting. The first true leaf was emerging at this time. The N rates used were 0, 30, 60, 90 and 120 lbs of actual nitrogen per acre. Each treatment was replicated five times. The plots were hand harvested on September 23, 1991.

Results and Discussion

The growing season precipitation was much above normal and plants were not water stressed at this site. The average grain yields are shown in Table 13.

Table 13. Average corn grain yields for the nitrogen study, Watertown Station, 1991.

Rate of N	Grain Yield
lb/acre	bu/acre (15%)
0	132
30	141
60	142
90	143
120	142
Sign. of F	0.008

Corn grain yields were significantly influenced by nitrogen treatments. The 9 bu/acre response appears to be from 30 lbs of nitrogen or less. This response to this level of nitrogen is not surprising. The estimated N requirement for 132 bu/acre corn would be 190 lbs/acre. There was 124 lbs available N in the top four feet this spring and 115 lbs NO_3-N/acre after harvest. Therefore, most of the N that was taken up by the corn came from organic matter breakdown, including the previous year's legume contribution. This mineralization contribution was approximately 150 lb N/acre if we assume the full 30 pounds of added nitrogen was needed.

In summary, a 9 bushel corn yield increase was seen from about 30 lbs/acre of added nitrogen. The apparent mineralization of organic nitrogen was much higher than expected. The amount of nitrogen becoming available each year through organic matter decay depends greatly on weather conditions, past crop and tillage. Even with this limitation, the nitrate-nitrogen test can prevent excess nitrogen from being applied to fields where available soil nitrogen is well above crop N needs.

SPRING WHEAT FOLIAGE FUNGICIDE TRIALS IN NE SOUTH DAKOTA IN 1991

G.W. Buchenau, Shaukat Ali, F.A. Cholick & J.D. Smolik

Foliage fungicide trials were conducted at two locations in Northeast South Dakota in 1991, one at the northeast experiment station near South Shore (experiment 1) and the other located on the Dean Johnson farm near Pierpont (experiment 2). Both experiments were part of a program designed to test the validity of tanspot prediction systems and related spray advisories, and also to provide additional data for improving these systems. The objectives and experimental designs were similar at each location, therefore we will present the results of both experiments here.

Materials & Methods:

In experiment 1, Butte 86 was planted on April 18 using a commercial grain drill with the middle rows blocked to provide 7 row plots 42" wide by 15' long. The plots were separated by a one foot space on the sides, and a 5 ft alleyway at either end. Fungicide treatments were arranged in a randomized complete block design with 5 replications.

In experiment 2, seven-row plots were planted on 20 ft centers on 9 April with a small plot planter. Six foot alleys were maintained between plots, and these were planted to winter wheat which served as a ground cover and a rust spreader. The plots were arranged in a randomized complete block design with 4 replications.

Fungicides were applied with a CO_2 pressurized spray rig calibrated to deliver 30 gallons of liquid per acre at 30 psi. As originally planned, fungicide schedules were based on 1) 'Traditional' application schedules and dosages for the fungicides, and 2)weather driven schedules based on the frequency and timing of infection periods. Problems with the rainfall data from the automatic weather station at the NE farm precluded efficient use of the programs and we used manual weather data for implementing modified weather driven schedules. Weather/disease driven fungicide application 'triggers' in experiment 1 were 1)after 1-2 lesions were present on 2nd (penultimate) leaves and growth stage was before 3/4 berry, and 2) following the first rain after heading. In experiment 2, only one such trigger-the first rain after heading-was used. Data from all tentative weather driven treatments for which the triggers were not pulled (i.e., not receiving fungicides) were included in the means for 'untreated' plots.

Infection periods in experiment 1 were determined using our SEPTORI modification of EPINFORM, a system originally developed for Septoria diseases in Montana. In addition, dew period duration and temperature during the dew period was integrated into Blitecast indices according to the Wallin criteria used to forecast potato late blight in other areas. In this, each day is rated on a 0-4 scale, with zero indicating no infection, and 4 indicating a very favorable infection period. Since no automated weather station was present near experiment 2, rainfall at Aberdeen and the NE Farm were used to estimate infection periods.

In addition to fungicide application, KCl was applied to certain treatments as a postplant application at 120 lb/A.

Results:

A. Experiment 1.

Tanspot developed slowly in both experiments in spite of the unusually high rainfall at each site. We attribute the late initiation of infection in Experiment 2 to the low level of inoculum that overwintered on the soybean residue. This argument however, does not hold true for experiment 1 which was on ground previously cropped to wheat. Furthermore, we observed mature pseudothecia (overwintering structures) of the causal fungus in the plots on 9 May, albeit they were relatively few in number on the rather light surface residue. Our modification of EPINFORM indicated that 5 infection periods occurred in experiment 1 during the season. These infection periods are based on temperature and rainfall, and the duration of a latent interval between periods is governed by degree-days. Specifically, infection periods occurred on 27 April, 29 May, 4 June, 14 June and 26 June. However, the first leaf had not emerged on 27 April (Table 14), therefore no infection could have occurred. The weather data indicate that no other infection periods occurred before the 29 May period. Therefore, this was the effective primary infection period at the site. Since ascospores that were mature in early May were likely discharged by mid-month, it is probable that much of the overwintering inoculum was dissipated by the time weather conditions favored primary infection. Some of the pertinent information on growth stages and related weather events is presented in Table 14 and Figure 2.

Fungicide treatment significantly affected tanspot but not yield or seed size (Table 15). In particular, 2 or 3 applications of mancozeb reduced disease the most. It appears that the applications made on date 163 (12 June, boot stage) was most critical since the single application made on day 171 did not result in control, and the three application schedule starting on day 156 was not better than the two applications made on day 163 and 171. Disease was present in only trace amounts on the flag leaves on day 163, and second leaves averaged about 2.5 lesions. By day 171, disease had increased only slightly to 0.6 and 3.6 lesions per flag and 2nd leaf, respectively.

Soil applied chloride did not reduce tanspot in plots receiving no fungicide, but reduced tanspot in Tilt sprayed plots. The nature of this unusual interaction is not clear at this time.

Neither yield not test weight were significantly increased by fungicide or chloride treatment. This probably was due to the overriding influence of an uncontrolled scab epidemic.

B. Experiment 2 (Day Co).

Disease in experiment 2 started very late in the season in spite of frequent, heavy rains. Flag leaves had 0, 0.05 and 0.2 lesions on 5 June, 12 June (heading) and 24 June respectively. Similarly, 2nd leaves had 0.2, 0.2 and 1.66 lesions on the same dates. However, from boot to milk stages, tanspot on flag leaves increased at a rate of r=0.23. This value represents a moderately fast rate of increase.

Most fungicide treatments reduced flag leaf disease significantly or nearly so, particularly 3 applications of mancozeb (Table 16). There also was a tendency for some control with soil applied KCl, but the difference was not significant with or without Tilt protection. The late application of mancozeb was apparently responsible for a large part of the disease reduction on flag leaves, but this was not so apparent on second leaves. Neither yield nor kernel weight were affected by fungicide treatment, probably because of extensive damage due to headblight (scab) which was not controlled by any of the treatments.

Table 14. Growth and maturity of Butte 86 spring wheat in experiments 1 and 2 in 1991 as predicted by growing degree days and periodically verified.

Emergence of Leaf or Growth Stage	Exp 1 (Northeast Farm)		Exp 2 (Day Co.)	
	Date	Day of Year	Date	Day of Year
Planted	18 April	108	9 April	99
Leaf 1	8 May	128	25 April	115
Leaf 2	12 May	132	4 May	124
Leaf 3	16 May	136	11 May	131
Leaf 4	21 May	141	16 May	136
Leaf 5	25 May	145	21 May	141
Leaf 6	29 May	149	25 May	145
Leaf 7	2 June	153	29 May	149
Leaf 8	7 June	158	2 June	153
E Boot	10 June	161	7 June	158
Heading	18 June	169	11 June	162
Anthesis	19 June	170	14 June	165
Milk	8 July	189	7 July	188
Dough	16 July	197	15 July	196
Hard Ripe	20 July	201	19 July	200
Harvested	5 Aug	217	5 Aug	217

Table 15. Results of the 1991 foliage fungicide experiment 1 (N. E. Farm).

Treatment	Application Dates	Tanspot on Flag Leaves 9 July (190)	Yield (Bu/A)	1000 KWT g
No fungicide, no KCl	–	30.3	19.1	23.69
No fungicide, + KCl[a]	(129)	29.0	17.9	23.30
TILT, 50 g ai, 0 KCl	156	25.0	19.5	24.15
TILT, 50 g ai, + KCl	156	13.0	21.2	24.47
Mancozeb, 1.5 lb ai/A/Appl, 0 KCl	156, 163, 171	11.0	17.2	23.23
Mancozeb, 1.5 lb ai/A, 0 KCl	163, 171[b]	14.0	18.0	23.21
Mancozeb, 1.5 lb ai/A, 0 KCl	171[c]	37.0	16.2	23.08
Bayleton, 2 oz ai/A, 0 KCl	163[b]	29.5	18.7	23.87
$FLSD_{.05}$		12.2**	(3.7)	(1.11)
Ck vs. any		10.0	3.0	0.90

[b]Trigger 1 - When disease $\geq$ 1 lesion/2nd leaf + maturity < full berry.
[c]Trigger 2 - Following the 1st rain after heading

Table 16. Results of the 1991 spring wheat foliar fungicide experiment 2 (Day Co.).

Treatment & Application Date(s) and Rate (ai) per Application per Acre	Tanspot on Flag Leaves 9 July (Late Milk) %	Tanspot on Flag Leaves 15 July (dough) %	Yield bu/A	1000 KWT g
Unsprayed check, 0 KCl[a]	42.5	63.5	46.0	30.71
Unsprayed check, + KCl	31.3	68.9	43.2	30.60
Tilt, 50g ai/A, Day 156, 0 KCl	27.5	60.0	43.4	29.38
Tilt, 50g ai/A, Day 156, + KCl	21.3	73.8	47.6	30.03
Mancozeb, 1.5 lb/A, Day 156 & 175	2.0	30.0	47.8	32.50
Mancozeb, 1.5 lb/A, Day 175	15.0	52.5	47.4	30.48
Bayleton 2 oz/A, Day 163	28.8	50.0	47.1	31.43
Bayleton 4 oz/A, Day 175	20.0	51.3	47.0	31.35
$FLSD_{.05}$	18.4**	21.3**	(4.36)	(3.4)
Ck vs Other	14.5	16.8	3.1	2.6

[a]Mean of 16 observations, all others are means of 4 observations.
**Significant at $P \geq .01$

<u>Statistical Summary:</u>

Regression of Yield on 9 July Tanspot = 48.5 - 0.82 (% Tanspot), $p = .004$, $R^2 = 0.18$.
Regression of % Yield Loss on 9 July Tanspot = 0 + 0.17* (% Tanspot).
Regression of Yield on 15 July Tanspot NS.
Correlation between Tanspot on 9 July and 15 July = 0.53**.

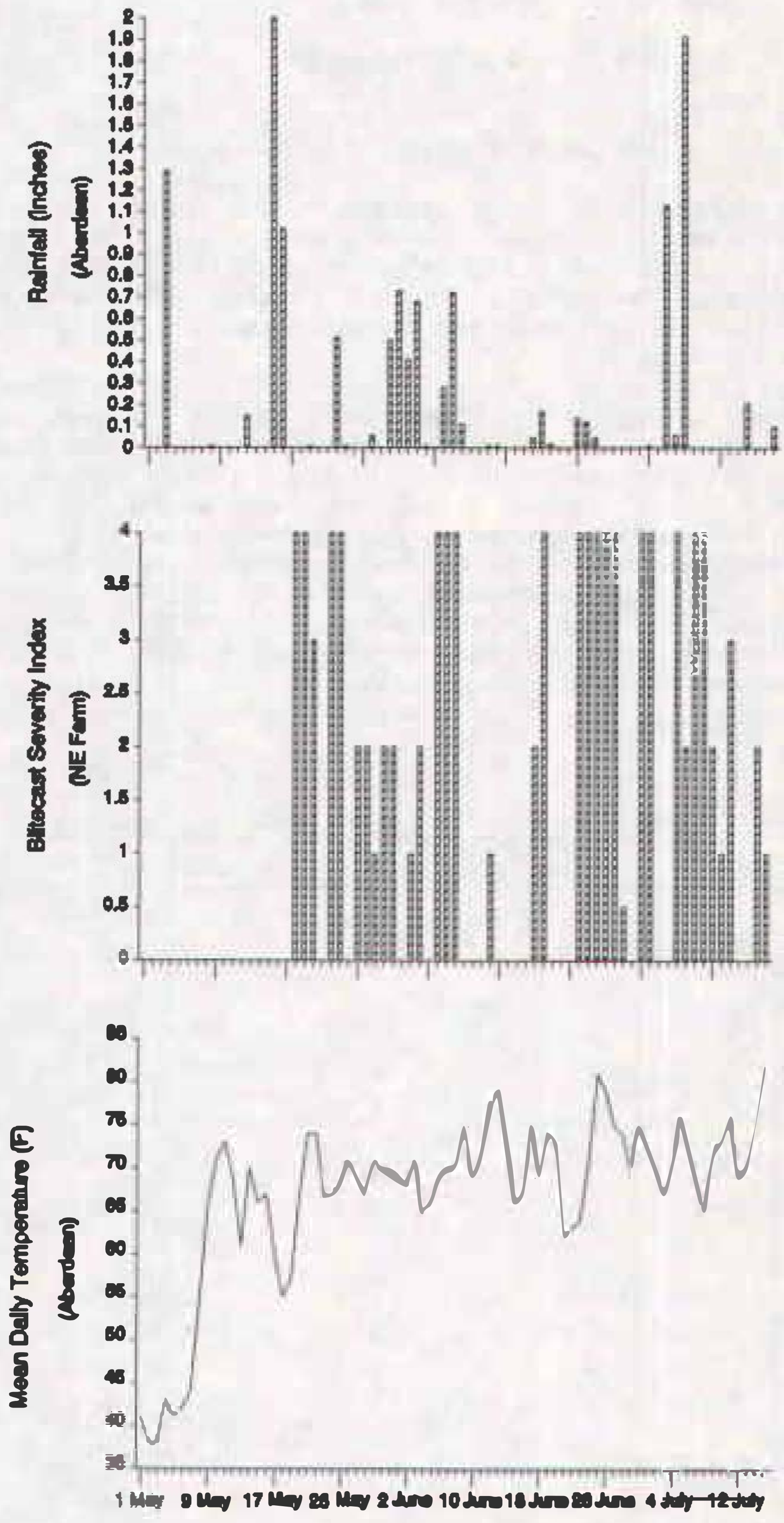


Figure 2. Weather variables affecting Exp. 1 & 2 in 1991.

SOYBEAN POPULATION STUDY, 1991

J. Smolik, T. Machacek and L. Evjen

Objectives: Determine effect of plant population on yield of Simpson soybean.

Methods: Plots were planted on May 20. The previous crop was corn and stalks had been fall chisel plowed. The plot area was disced and harrowed prior to planting. Plots were 12' wide (four 36" rows) and 30' long. Lasso was banded at planting and all treatments were cultivated twice. Four seeding rates (120,000, 150,000, 180,000 and 210,000 seeds/A) were arranged in a randomized complete block design with four replications. Just prior to harvest, final plant population was recorded.

Results: The higher seeding rates significantly increased yield (Table 17). However, there was no significant difference in yield between the two lowest seeding rates or between the two highest seeding rates. The regression analysis indicated a linear yield response to increasing plant populations (Fig. 3). In the 30-42 bushel yield range, for each 11,000 plant population increase at harvest, yield was increased one bushel. Results of this study, together with similar results obtained in 1990 (See Soybean Row Space Study, 1990 NE Station Progress Report), suggest that area soybean producers might benefit from increasing seeding rates to 180,000 seeds/A. Although results of this study indicated that even higher seeding rates may increase soybean yield, such excessive rates should be evaluated in terms of the increased costs associated with seed purchase and handling.

Table 17. Effect of plant population on yield of Simpson soybeans, N.E. Station, 1991.

Seeding Rate/A	Yield (Bu/A)	Population at Harvest/A
120,000	34.3[a]	87,000
150,000	35.3	135,500
180,000	39.6	145,000
210,000	42.3	235,000
$FLSD_{.05}$ =	3.5	

[a]Average of four replications.

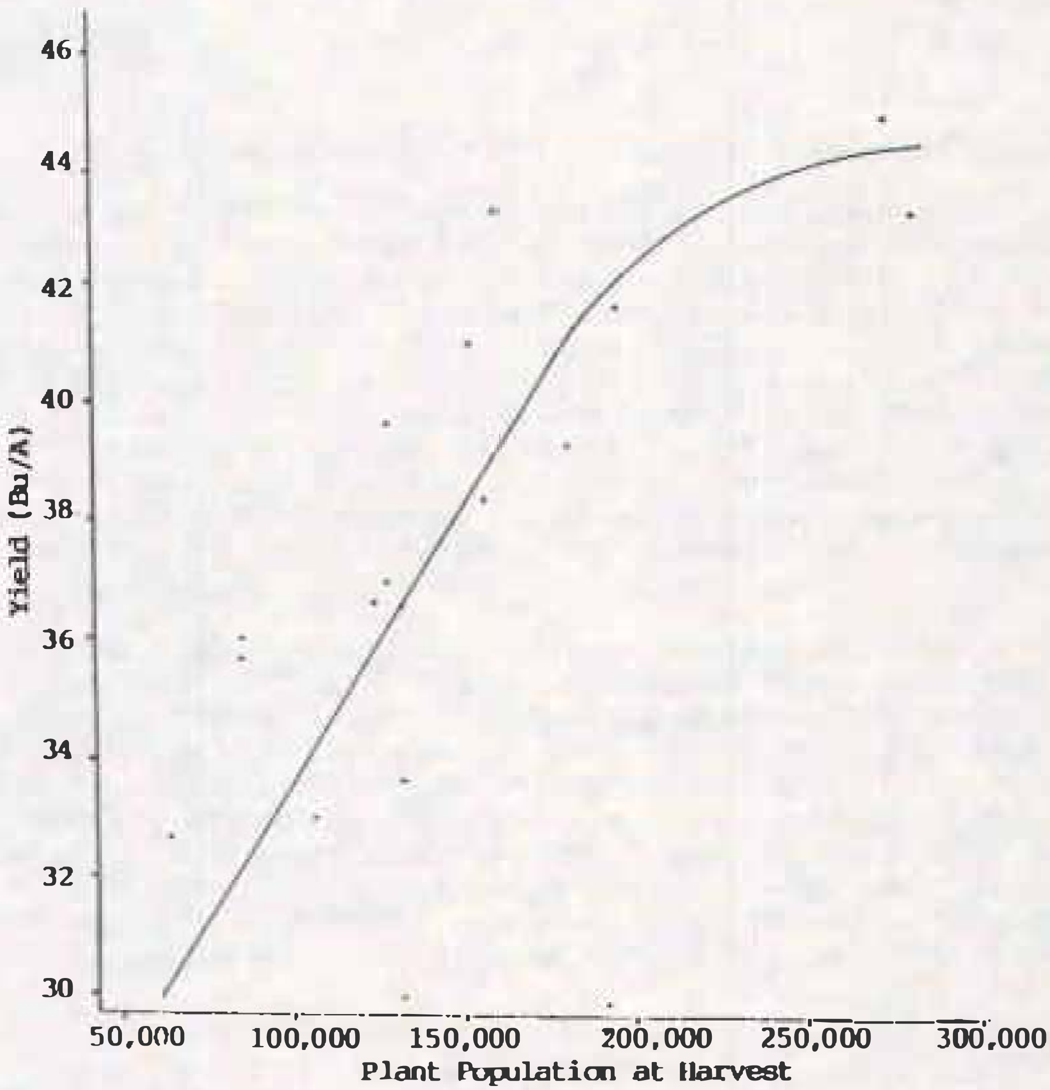


Figure 3. Relationship of plant population and soybean yield.

SOYBEAN ROW SPACE STUDY, 1991

J. Smolik, L. Evjen and A. Heuer

Objectives: Determine effect of row spacing on yield of Simpson soybeans.

Methods: Plots were planted May 20 in five row spacings (7", 14", 21" 28" and 35") with four replications of each treatment. Variety Simpson was seeded with a J.D. press drill with openers spaced at 7". The drill was used to seed all plots, and the respective row spacings were obtained by blocking selected seed ports. Plots were 9' wide and 30' long. We attempted to seed all treatments at 180,000 seeds/A. The 21", 28" and 35" treatments were cultivated twice. The previous crop in the study area was corn. The plot area had been fall chisel plowed and was disced and harrowed prior to seeding. Lasso was broadcast shortly after planting for foxtail control, and several weeks later Poast was applied for control of volunteer corn. Both kochia and Russian thistle were troublesome in the 7" and 14" row spacings, and a considerable amount of hand weeding was required in these treatments. The outside rows in the 7" and 14" spacings were removed prior to harvest in an attempt to reduce border effects.

Results: The 7" row spacing significantly out-yielded all other row spacings (Table 18). There was no significant difference in yield between the 14, 21 and 28" row spacings, however, all three of these spacings out-yielded the 35" spacing. It is very likely that at least a portion of the yield increase observed in the 7" spacing was due to the higher plant population recorded in this treatment (Table 18). As indicated in the 1991 population study (Table 17), soybeans responded very well to higher populations under moist 1991 growing conditions at the NE Station. The range of plant populations at harvest reflects the difficulty in achieving uniform populations when seeding wider rows with a conventional grain drill.

In interpreting this study it should be noted that in a more normal precipitation year (1990) there was no consistent yield difference between 7" and 36" row spacing (See 1990 NE Station Annual Report).

Table 18. Effect of row spacing on yield of Simpson soybeans, NE Station, 1991.

Row Spacing (inches)	Yield (Bu/A)	Plant population at Harvest/A
7	51.1	224,000
14	44.9	165,000
21	46.5	124,500
28	45.6	122,000
35	39.1	111,000
$FLSD_{.05}$ =	4.2	

[a]Average of four replications.

EFFECT OF MECHANICAL/CHEMICAL WEED CONTROL TREATMENTS ON YIELD OF SPRING WHEAT, NE STATION, 1991

J. Smolik, T. Machacek, K. Compton, D. Vos and L. Evjen

Objectives: Determine effect of weed control treatments on yield of spring wheat.

Methods: The plot area was fertilized with 50 lb N/A, and was field cultivated and harrowed prior to seeding Butte 86 on April 11. The previous crop was soybean. Plots were 21' wide and 60' long. An 8-foot wide swath was harvested from the center area of each plot for yield determination. The four treatments (check, Rotary hoe 1X, Rotary hoe 2X, and Hoelon 2 pt + Buctril 1 pt) were arranged in a randomized completed block design with four replications. The first rotary hoeing was approximately 2 weeks after emergence and the second hoeing approximately 4 weeks after emergence.

Results: There were no significant yield differences between any of the treatments (Table 19). Numbers and biomass of grasses and broadleaves also were not significantly different between treatments. However, the total biomass of both grasses and broadleaves in the Hoelon + Buctril treatment were significantly lower than the check and one rotary hoeing. Visual estimates of percent foxtail control were significantly different between treatments, but were not well correlated with grass counts or biomass. The overall low yields recorded in this study were a result of the high incidence of head scab in 1991. The treatment with the highest economic return (gross income minus only weed control costs) was the control (Table 19). Returns to the rotary hoeing treatments were nearly equal. Economic return to the Hoelon plus Buctril treatment was well less than half of that to the control.

Table 19. Effect of weed control treatments on spring wheat yield, weed populations, and economic returns.

Treatment	Yield (Bu/A)	Weed number/3 ft²		% foxtail control (visual)	Weed biomass lbs/A dry wt			Weed control costs/A	Gross Income/A minus weed control costs
		Grass	Bdlf		Grass	Bdlf	Total		
Control	16.3[a]	143	23	0	499	208	707	$0.00[b]	$46.46[c]
Rotary hoe 1X	14.5	158	30	25	537	138	674	$2.37	$38.96
Rotary hoe 2X	15.2	135	10	50	333	65	400	$4.74	$38.58
Hoelon 2 pt + Buctril 1 pt	15.3	102	17	83	185	58	242	$22.71	$20.90
$FLSD_{.05}$ =	NS	NS	NS	7.0	NS	NS	344		

[a]Average of four replications. Grass was primarily yellow foxtail, broadleaves (Bdlf) were primarily redroot pigweed, Kochia and Russian thistle.
[b]Costs include fuel, lubricants, herbicides, repairs, labor and fixed costs.
[c]Assumes spring wheat selling price of $2.85/bu. No deficiency payments included.

We thank Tom Dobbs and Dave Becker, Economics Department, for their assistance with the economic analyses.

COSTS AND RETURNS ASSOCIATED WITH THE 1990 MECHANICAL/CHEMICAL WEED CONTROL STUDIES IN CORN, SOYBEANS AND SPRING WHEAT

J. Smolik and S. Van Der Werff

The effects of treatments on crop yields and foxtail biomass are presented in Table 20. Details of the agronomic methods and results in these studies were included in the 1990 NE Station Annual Progress Report (pages 36-40). The economic returns in Table 20 are gross income minus only weed control costs. In the corn study the two treatments with the highest economic returns were cultivating twice, and banding Lasso II at 7 lb plus cultivating once. Economic returns to the hoe 2X, cult 2X and the drag 1X, hoe 1X, cult 2X treatments were nearly equal. With the exception of the control, the least profitable treatment was cultivating once.

In the soybean study the most profitable treatment was rotary hoeing 1X and cultivating twice (Table 20). The hoe 2X, cult 2X, walk, and the drag 1X, cult 2X treatments were the next most profitable. In the spring wheat study the control was the most profitable treatment followed by rotary hoeing once. The least profitable treatment was 2 pt Hoelon plus 1 pt Buctril.

Results in these studies suggest that mechanical methods of weed control can provide acceptable levels of weed control and also are economically competitive with chemical control methods.

Table 20. Weed control costs and returns in the 1990 mechanical/chemical weed control studies in corn, soybean, and spring wheat.

Crop	Treatment	Yield (Bu/A)	lbs foxtail/A (dry wt)	Weed control cost/A[b]	Gross Income/A minus weed control costs[c]
Corn	Control	43.0[a]	4664	$0.00	$90.30
	Cult 1X	69.1	1695	$4.26	$140.85
	Cult 2X	99.9	768	$8.52	$201.27
	Hoe 1X, Cult 2X	91.2	77	$10.89	$180.63
	Hoe 2X, Cult 2X	95.8	384	$13.26	$187.92
	Drag 1X, Cult 2X	88.1	416	$11.46	$173.55
	Drag 1X, Hoe 1X, Cult 2X	95.2	896	$13.83	$186.09
	Lasso II, band, + Cult 1X	101	528	$10.21	$201.89
	$FLSD_{.05}$	13.1	1019		
Soybeans	Control	20.5	2642	$0.00	$118.00
	Cult 1X	32.8	19	$4.26	$185.98
	Cult 2X	34.5	77	$8.52	$191.58
	Hoe 1X, Cult 2X	37.2	96	$10.89	$204.87
	Hoe 2X, Cult 2X	36.0	80	$13.26	$195.54
	Drag 1X, Cult 2X	36.4	511	$11.46	$199.66
	Drag 1X, Hoe 1X, Cult 2X	32.9	214	$13.83	$176.99
	Hoe 2X, Cult 1X	32.9	182	$9.00	$181.82
	Hoe 2X, Cult 2X, Walk	37.3	3	$15.40	$200.94
	Lasso II band + Cult 1X	33.9	118	$10.21	$186.41
	$FLSD_{.05}$ =	3.1	451		
Spring Wheat	Control	48.4	137	$0.00	$113.74
	Rotary Hoe 1X	49.0	387	$2.37	$112.78
	Rotary Hoe 2X	43.1	343	$4.74	$96.55
	Hoelon 2 pt + Buctril 1 pt	48.3	74	$20.78	$92.73
	$FLSD_{.05}$ =	3.9	109		

[a]Average of 4 replications
[b]Costs include fuel, lubricants, herbicide, repairs, labor, and fixed costs
[c]Assumed selling prices (1990): corn $2.10; soybeans $5.80; spring wheat $2.35. No deficiency payments included.

EFFECT OF MECHANICAL/CHEMICAL WEED CONTROL TREATMENTS ON CORN YIELD AND WEED POPULATIONS

J. Smolik, T. Machacek, K. Compton, D. Vos, and L. Evjen

Objectives: Determine effect of mechanical and chemical weed control treatments on corn yield.

Methods: The previous crop in the study area was spring wheat, and the stubble had been fall chisel plowed. The plot area was fertilized with 50 lb N/A, and was field cultivated and harrowed prior to planting. Pioneer brand corn hybrid 3790 was seeded at 18,500 seeds/A on 10 May. Plots were 4-36" rows wide and 28' long. Four treatments (Check, Cultivate 1X, Cultivate 2X and Lasso II banded at 7 lb plus Cultivate 2X) were arranged in a randomized complete block design with four replications. The first cultivation was 25 days after planting and was followed by a second cultivation 14 days later.

Results: All of the weed control treatments significantly increased yield compared to the check, and yield differences between the weed control methods were also significantly different (Table 21). The highest yield occurred in the Lasso plus cultivate treatment. All weed control methods significantly reduced grass number and biomass, however, there was no significant difference between Cult 2X and Lasso plus Cult 2X. Differences in broadleaf populations were not statistically significant. The yield increase between Cult 2X and Lasso plus Cult 2X (Table 21) was not correlated with grassy weed control. It is possible that the early season in-row weed control provided by Lasso was responsible for the yield increase. The regression analyses indicated 0.21 bushel of corn was lost for each foxtail plant per 3 ft^2, and also that a bushel of corn was lost for each 45.8 lbs/A of foxtail produced. The regression analyses for visual estimates of foxtail control indicated yield was increased 7.4 bushel for each 10% increase in grass control. The highest economic return (gross income minus <u>only</u> weed control costs) was to the Lasso plus Cult 2X treatment, followed by the Cult 2X treatment. The benefit of only one cultivation to both yield and economic return was also apparent.

Table 21. Effect of weed control treatments on corn yield, weed populations and economic returns.

Treatment	Yield (Bu/A)	Weed numbers/3 ft^2		% foxtail control (visual)	Weed Biomass lbs/A dry wt		Weed control costs/ A	Gross Income/ A minus weed control costs
		Grass	Bdlf		Grass	Bdlf		
Check	17.1[a]	347	19	0	3125	193	\$0.00[b]	\$36.77[c]
Cult 1X	45.8	213	6	54	2261	80	\$4.26	\$94.21
Cult 2X	71.7	82	8	78	665	35	\$8.52	\$145.64
Lasso II, band + Cult 2X	84.4	86	24	87	652	141	\$15.17	\$166.29
FLSD$_{.05}$ =	9.5	80	N.S.	5	681	N.S.		

[a]Average of four replications. Grass was primarily yellow foxtail, broadleaves (Bdlf) were primarily redroot pigweed, Kochia and Russian thistle.
[b]Costs include fuel, lubricants, herbicide, repairs, labor and fixed costs.
[c]Assumes corn selling price of \$2.15/bushel. No deficiency payments included.

We thank Tom Dobbs and Dave Becker, Economics Department, for their assistance with the economic analyses.

EFFECT OF MECHANICAL/CHEMICAL WEED CONTROL TREATMENTS ON YIELD OF SOYBEAN - NORTHEAST STATION, 1991

J. Smolik, T. Machacek, K. Compton, D. Vos and L. Evjen

Objectives: Determine effect of mechanical and chemical weed control treatments on soybean yield and on weed populations.

Methods: Plots were planted May 20 with soybean variety Simpson. Seeding rate was 180,000 seeds/A. The previous crop was corn, and the plot area had been fall chisel plowed. Prior to seeding the plot area was disced and harrowed. Individual plots were 12' wide (4-36" rows) and 30' long. The four treatments (Check, Cultivate 1X, Cultivate 3X, and Lasso II banded at 7 lb plus Cultivate 3X) were arranged in a randomized complete block design with four replications. The first cultivation was 20 days after planting, and the second cultivation 34 days post-plant. A very heavy rain in late June resulted in a flush of foxtail, and a third cultivation was required 51 days after planting.

Results: All of the weed control treatments significantly increased yield compared to the check (Table 22). Also, yield of the Cult 3X and Lasso plus Cult 3X treatments were significantly higher than Cult 1X. However, the yield difference between Cult 3x and Lasso II plus Cult 3X was not significant. Relationships similar to those for yield were recorded for grass numbers and biomass. Visual estimates of foxtail control related well to foxtail biomass. Broadleaf numbers were low in all treatments, but all weed control treatments reduced numbers compared to the check. Regression analyses indicated 0.065 bushel of soybean was lost for each foxtail plant per 3 sq ft, and each 10% increase in visual foxtail control increased soybean yield 1.6 bushel. Interestingly, this was the same relationship for visual estimates obtained in a similar study conducted in 1990 (See 1990 NE Station Annual Progress Report, p. 32). The best relationship (R^2 = 0.88) was obtained for foxtail biomass and yield, and this analysis indicated a bushel of soybean was lost for each 192 lbs/A of foxtail produced. This relationship compares reasonably well with results obtained in a 1990 study, in which a bushel of soybean was lost for each 230 lbs/A of foxtail produced. The highest economic returns (gross income minus only weed control costs) were to the Lasso plus Cult 3X treatment, followed by the Cult 3X treatment (Table 22).

Results of this study and that conducted in 1990 suggest that mechanical methods of weed control can provide acceptable levels of weed control in soybean.

Table 22. Effect of weed control treatments on soybean yields, weed populations and economic returns.

Treatment	Yield (Bu/A)	No. of Weeds/3 ft²		% Foxtail control (visual)	Weed Biomass lbs/A dry wt		Weed Control Costs/A	Gross Income/A Minus Weed Control Costs
		Grass	Bdlf		Grass	Bdlf		
Check	24.8[a]	222	9	0	2536	381	$0.00[b]	$130.20[c]
Cult 1X	31.0	167	3	53	1945	13	$4.26	$158.49
Cult 3X	38.0	31	1	82	134	45	$12.78	$186.72
Lasso II band + Cult 3X	40.1	28	2	93	64	22	$19.43	$191.10
$FLSD_{.05}$ =	3.7	55	3	7.6	672	NS		

[a]Average of four replications, grass was primarlly yellow foxtail, broadleaves (Bdlf) were primarily redroot pigweed, Russian thistle and Kochia.
[b]Costs include fuel, lubricants, herbicide, repairs, labor and fixed costs.
[c]Assumes soybean selling price of $5.25 bushel.

We thank Tom Dobbs and Dave Becker for their assistance with the economic analysis.

W.E.E.D. PROJECT DEMONSTRATIONS

L. J. Wrage, P. O. Johnson, D. A. Vos, and S. A. Wagner

Weed evaluation and extension demonstration plots provide data for northeastern South Dakota. The W.E.E.D. Project program includes demonstrations of labeled treatments in all major crops and experimental herbicides in corn, flax, alfalfa, edible beans, and potatoes.

Demonstration plots provide side-by-side comparison of herbicides. Rates used are those best suited for the weed and soil type. Plots are evaluated for weed control and crop tolerance. Yields are harvested from replicated tests. Data collected are summarized over several years to provide a more accurate measurement of expected performance. These plots are used for tours and form the basis for educational material.

Data for 1991 tests are reported in the 1991 Herbicide Reports which are available in County Extension Offices. Evaluations for all major crops for the area are included. The station provides the only site for evaluating weed control in sunflowers, potatoes, and edible beans.

The crops included in 1991 are listed below:

<u>1991 Evaluation/Demonstration Tests</u>

1. Corn Herbicide Demonstration
2. Foxtail Removal Timing in Corn
3. Evaluation of Formulations of PPI Corn Treatments
4. Soybean Herbicide Demonstration
5. Evaluation of Russian Thistle Control in Soybeans
6. Evaluation of Foxtail Control in Spring Wheat
7. Flax Herbicide Demonstration
8. Sunflower Herbicide Demonstration
9. Edible Bean Herbicide Demonstration
10. Potato Herbicide Demonstration
11. Alfalfa Demonstration

<u>Experimental Herbicide Evaluation Tests</u>

Evaluation of Acetochlor Performance in Corn
Evaluation of Experimental Grass and Broadleaf Herbicide Combinations for Postemergence Weed Control in Soybeans
Postemergence Herbicides for Grass and Broadleaf Weed Control in Alfalfa
Fallow Weed Control

Performance in 1991 reflects weather conditions. Late season precipitation extended weed flushes and increased late weed growth. Plot information and weather data are summarized for each test. Weed control is reported as a visual evaluation compared to an untreated check. Crop effects are reported as VCRR (Visual Crop Response Rating) when differences are noted.

The cooperation and assistance from station personnel is acknowledged. Extension agents identify needs, assist with tours, and utilize the data in producer programs.

FARMING SYSTEMS STUDIES, 1991

Principal Investigators:

Jim Smolik (Project Leader), Jim Gerwing, Diane Rickerl, Tom Schumacher, Howard Woodard, and Leon Wrage; Technicians: Loyal Evjen, Tom Machacek and Kim Compton.

Cooperators:

George Buchenau, Fred Cholick, Tom Dobbs, Paul Evenson, Paul Johnson, Kevin Kephart, David Becker, and Don Taylor.

Introduction:

The farming systems studies were established in 1985. The systems consist of three or four year rotations. These are comparatively long-term studies (8 years) since the effects of rotations are best measured after completion of at least two cycles. The plots are relatively large scale (3000 sq. ft. in Study I and 2000 sq. ft. in Study II) in an attempt to minimize border effects. The systems and rotation schedules in Study I are: ALTERNATE (no commercial fertilizer or pesticide and no moldboard plow), oats/alfalfa - alfalfa - soybean - corn; CONVENTIONAL, corn - soybean - spring wheat; RIDGE-TILL, corn - soybean - spring wheat. The systems in Study II are: ALTERNATE, oats/clover - clover (green manure) - soybean - spring wheat; CONVENTIONAL, soybean - spring wheat - barley; MINIMUM-TILL, soybean - spring wheat - barley. The 1988-1991 studies were supported in part by USDA LISA Grant LI-88-12.

Objectives:

- A. Measure yields and economic returns.
- B. Determine influence of farming system on soils' ability to supply plants with mineral nutrients.
- C. Measure effect of farming system on soil temperatures, soil strength, bulk density, residue cover, and snow catch.
- D. Measure beneficial and harmful arthropod populations and measure insect damage.
- E. Compare populations of plant feeding, predaceous and microbial feeding nematodes.
- F. Determine populations of fungi and bacteria, and measure mycorrhizal associations and soil fungistatic properties.
- G. Determine effect of farming systems on earthworm populations.
- H. Determine weed species present and densities.
- I. Measure effect of farming systems on soil water contents.

Cultural Practices

Fertilizer and pesticide inputs in the conventional, ridge-till, and minimum-till systems are based on current Plant Science Department recommendations. The cultural practice information for the various systems is listed in Tables 23-26.

Table 23. Cultural practice information - farming systems studies, 1991.

Study I	Planting date	Fertilizer N-P-K (lb/A)	Manure	Herbicide (Actual/A)	Hand weeding (hr/A)
Corn					
Alternate	May 10	--		--	--
Conventional	May 10	85-0-0		Lasso II, 7 lb. band	--
Ridge-till	May 10	85-0-0		Lasso II, 7 lb. band,	--
Soybean					
Alternate	May 14	--		--	--
Conventional	May 14	--		Treflan, 2 pt.	--
Ridge-till	May 15	--		Lasso II, 7 lb. band, also post-emergence spray of 15 oz. Cobra	--
Spring Wheat					
Conventional	April 9	85-0-0		Hoelon, 2 pt + Buctril, 1 pt	--
"Ridge"-till	April 9	99-0-0		Hoelon, 2 pt. + Buctril, 1 pt. Fall sprayed with Roundup at 1 qt/A*	--
Oats/Alfalfa	April 19	--	2.68 T/A Dry Matter 2.1%-0.73%-1.75% N-P-K	--	--
Alfalfa				--	--

NOTE: Seeding rates; Oats 74, Alfalfa 9.5, Spring Wheat 70, Corn 18,500 seeds/A, Soybean 180,000 seeds/A.
*Roundup applied for quackgrass control.

Table 24. Cultural practice information - farming systems studies.

	Tillage	
Study I	Pre-Plant	Post-Plant
Corn		
Alternate	Harrow 1x, field cultivate + harrow	Rotary hoe 2X and cultivate 2X, fall chisel plow
Conventional	Field cultivate + harrow	Cultivate 2X, fall chisel plow
Ridge-till	--	Cultivate 2X, ridge at last cultivation, chop stalks after harvest
Soybean		
Alternate	Harrow 1X, field cultivate + harrow	Rotary hoe 2X and cultivate 3X
Conventional	Disc 2X + harrow 1X (incorporate herbicide)	Cultivate 3X
Ridge-till	--	Cultivate 3X
Spring Wheat		
Conventional	Field cultivate and harrow	Fall plow
"Ridge"-till	Field cultivate	Ridge-till Cultivate (Build ridges for 1991)
Oats/Alfalfa	Disc + harrow	--
Alfalfa	--	Chisel plow 1X in September & field cultivate 1X

Note: The "ridge"-till spring wheat was seeded with a hoe-drill. All row crops in these studies are planted in 36" rows. Field packer was used after seeding Oats/Alfalfa. Ridges were formed after harvest of "ridge"-till spring wheat using the ridge-till cultivator. The spring-tooth harrow was used early preplant in the alternate corn and soybean as an aid in stimulating early weed growth, and thereby improving weed control with the final pre-plant tillage operation.

Table 25. Cultural practice information - farming systems studies.

Study II	Planting date	Fertilizer N-P-K (lb/A)	Herbicide (Actual/A)	Hand weeding (hr/A)
Spring Wheat				
Alternate	April 10	--	--	--
Conventional	April 10	65-0-0	Buctril, 1 pt.	--
Minimum-till	April 10	85-0-0	Buctril, 1 pt. Fall sprayed Roundup @ 1 qt/A*	--
Soybean				
Alternate	May 14	--	--	--
Conventional	May 14	--	Treflan, 2 pt.	--
Ridge-till	May 15	--	Lasso 7lb band, post-emerge Cobra applied at 15 oz.	--
Barley				
Conventional	April 11	0-0-0	MCPA, 1 pt.	--
Minimum-till	April 18	85-0-0	MCPA, 1 pt.	--
Oats/Clover	April 19	--	--	--
Clover		--	--	--

NOTE: Seeding rates; Oats 74, Sweet Clover 4.5, Red Clover 4.5, Spring Wheat 70, Barley 58, Soybean-180,000 seeds/A. A 50:50 mix of sweet clover and red clover has been used since 1987 in the alternate system.

*Roundup applied for quackgrass control.

Table 26. Cultural practice information - farming systems studies.

	Tillage	
Study II	Pre-Plant	Post-Plant
Spring Wheat		
Alternate	Field cultivate + harrow	Rotary hoe 1X, fall chisel plow
Conventional	Field cultivate + harrow	Fall plow
Minimum-till	Harrow 1X	Fall chisel plow
Soybean		
Alternate	Harrow 1X, and field cultivate + harrow 1X	Rotary hoe 2X, cultivate 3X
Conventional	Disc 2X + harrow 1X (incorporate herbicide)	Cultivate 3X
Minimum-till	--	Cultivate 3X
Barley		
Conventional	Field cultivate + harrow	Fall plow
Minimum-till	Field cultivate	Fall chisel plow
Oats/Clover	Field cultivate + harrow	--
Clover	--	Mow 2X and chisel plow in July, field cultivate in August

Note: The min-till spring wheat and barley were seeded with a hoe-drill. The min-till soybeans were seeded with a ridge-till planter. A field packer was used after seeding Oats/Clover.

Table 27. Small grain yields, farming systems studies, 1991.

Spring wheat var. Butte 86

Study I	Yield (Bu/A)[a]	Test wt.	Protein %	1000 Kernel wt (g)	% Scab	Root Rot (% Severe)
Conventional	13.6	53.0	17.5	26.2	2.3	56
"Ridge"-till	7.9	52.5	17.7	26.7	2.0	88
$FLSD_{.05}$	3.8	N.S.	N.S.	N.S.	N.S.	N.S.

Oats var. Don

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)
Oats/Alfalfa	41.4	34.6	11.0	30.61

Spring wheat var. Butte 86

Study II	Yield (Bu/A)	Test wt.	Protein %	Height at Harvest (in.)	1000 Kernel wt (g)	% Scab	Root Rot % Severe
Conventional	13.5	54.3	18.2	29.4	27.5	2.5	50
Alternate	18.8	55	16.4	31.8	28.0	2.5	83
Minimum-till	12.4	54.8	18.0	30.2	27.2	2.0	95
$FLSD_{.05}$	N.S.	N.S.	0.5	N.S.	N.S.	N.S.	21

Barley var. Robust

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)	% Scab
Conventional	47.1	42.4	12.7	31.58	2.7
Minimum-till	41.0	41.4	12.9	30.88	6.7
$FLSD_{.05}$	N.S.	N.S.	N.S.	N.S.	N.S.

Oats var. Don

	Yield (Bu/A)	Test wt.	Protein %	1000 Kernel wt (g)
Oats/Clover	46.3	35.1	10.5	29.34

[a]Avg. of four replications.

Table 28. Row crop yields - farming systems studies.

Study I	Corn - Pioneer Hybrid 3790	
	Yield (Bu/A) No. 2	Protein %
Conventional	116.8[a]	8.99
Ridge-till	109.4	9.50
Alternate	93.0	9.17
$FLSD_{.05}$	12.5	N.S.
	Soybeans - Simpson	
	Yield (Bu/A) 13% Moisture	Protein %
Conventional	37.6	39.34
Ridge-Till	28.1	41.19
Alternate	34.4	41.81
$FLSD_{.05}$	4.5	
Study II	Soybeans - Simpson	
	Yield (Bu/A) 13% Moisture	Protein %
Conventional	38.4	39.79
Minimum-till	26.1	40.75
Alternate	40.5	40.81
$FLSD_{.05}$	3.7	

[a]Avg of four replications.

Table 29. Forage crop yields - farming systems studies.

Study I	1st Cutting (June 6)	2nd Cutting (July 12)	3rd Cutting (August 22)	Total (T/A) Dry Matter
Alfalfa - Vernal	2.08	1.57	1.53	
Oat/Alfalfa	------- 1st Cutting - August 22 -------		1.16	6.34
Study II	-- Cut 25 June --			
Clover[b]	2.36			2.36

[a]Avg of four replications.
[b]Forage not removed

Tissue Analysis (% N-P-K):

Alfalfa	1st cutting, 3.22-.319-2.64 2nd cutting, 3.26-.307-3.54 3rd cutting, 4.05-.281-2.67
Oat/Alfalfa	1st cutting, 2.74-.232-2.16
Clover	2.25-.204-1.92

1991 CROP YIELDS

Small grain yields were 50 to 85% lower in 1991 compared to the previous year (Fig. 4). The extended period of warm, moist weather that accompanied heading of the spring wheat and barley crops resulted in severe infection levels of Fusarium Head Scab. Test weights and 1000 kernel weights were also substantially reduced (Table 27). The high percentage of shriveled spring wheat kernels resulted in higher protein levels. In contrast to most previous years, small grain yields in 1991 did not follow precipitation trends (Fig. 4), due primarily to scab. Levels of root rot in spring wheat grown in the reduced-till systems were higher than in the conventional systems. The higher level of root rot in the reduced-till systems has been noted in most previous years of this study. The greatest spring wheat yield reduction occurred in the R-T system. Corn residues are often associated with higher infection levels of Head Scab, and even though it had been two years since corn was grown, substantial amounts of partially decomposed corn residue were present in the R-T system when the spring wheat was planted. These residues apparently contributed to higher infection levels of scab which, in combination with the more severe root rot in this system, resulted in the higher yield reduction.

The abundant moisture resulted in corn and soybean yields that were 10 to 25% higher than 1990. Corn yields in the Conv and R-T systems were significantly higher than Alt (Table 28), which continues the pattern of most previous years. Soybean yields were among the highest recorded in these studies (Fig. 5), and yields in the Conv and Alt were significantly higher than in the reduced-till system in both studies. The lower yields in the reduced-till systems were apparently a result of the post-emergence herbicide applications (Tables 23 and 25). The herbicide application was deemed necessary as a result of increasing populations of both kochia and Russian thistle in these systems. Although the herbicide reduced populations of both weeds, it also resulted in a notable stunting of the soybeans. Forage yields were excellent and total alfalfa production was the highest recorded in these studies (Table 29 and Fig. 5). The ample precipitation in 1991 resulted in sufficient alfalfa regrowth following oat harvest to allow a seeding-year cutting of alfalfa, which contributed to the high total alfalfa production. Clover (green manure) yields were also very good, and in contrast to all previous years, a major portion (approximately 50%) of the clover produced was red clover. In all previous years of this study, most of the red clover has been lost due to winter kill, and the green manure produced was primarily yellow sweetclover.

The elemental composition of grains was not significantly different between systems in most instances in 1990 and 1991 (Table 30). However, nitrogen content of spring wheat was higher in the Conv and M-T compared to Alt, and in 1991 phosphorus content was higher in the Conv spring wheat in Study II.

Table 30. Elemental analysis of grain, Farming Systems Studies, 1990 and 1991.

		% N		% P		%K	
System	Crop	1990	1991	1990	1991	1990	1991
Conv	Barley	2.22[a]	2.03	0.353	0.343	0.69	0.48
M-T	Barley	2.22	2.06	0.340	0.367	0.66	0.48
Alt	Spring Wheat	2.33	2.88	0.343	0.393	0.56	0.48
Conv	Spring Wheat	2.56*	3.19*	0.329	0.414*	0.53	0.48
M-T	Spring Wheat	2.59*	3.16*	0.342	0.405	0.53	0.48
Conv	Spring Wheat	2.49	3.07	0.373	0.398	0.56	0.48
R-T	Spring Wheat	2.58*	3.10	0.334	0.390	0.56	0.48
Alt	Corn		1.47		0.260		0.51
Conv	Corn		1.44		0.282		0.53
R-T	Corn		1.52		0.245		0.50
Alt (Study I)	Soybean		6.69		0.563		1.80
Conv	Soybean		6.30		0.576		1.86
R-T	Soybean		6.59		0.547		1.83
Alt (Study 2)	Soybean		6.53		0.563		1.80
Conv	Soybean		6.36		0.555		1.92
M-T	Soybean		6.57		0.531		1.86
Alt (Study 1)	Oats	2.18	1.76	0.473	0.356	0.66	0.36
Alt (Study 2)		2.19	1.68	0.445	0.354	0.60	0.36

[a]Average of four replications.
* = significant increase at .05 level compared to same crop within system and year.

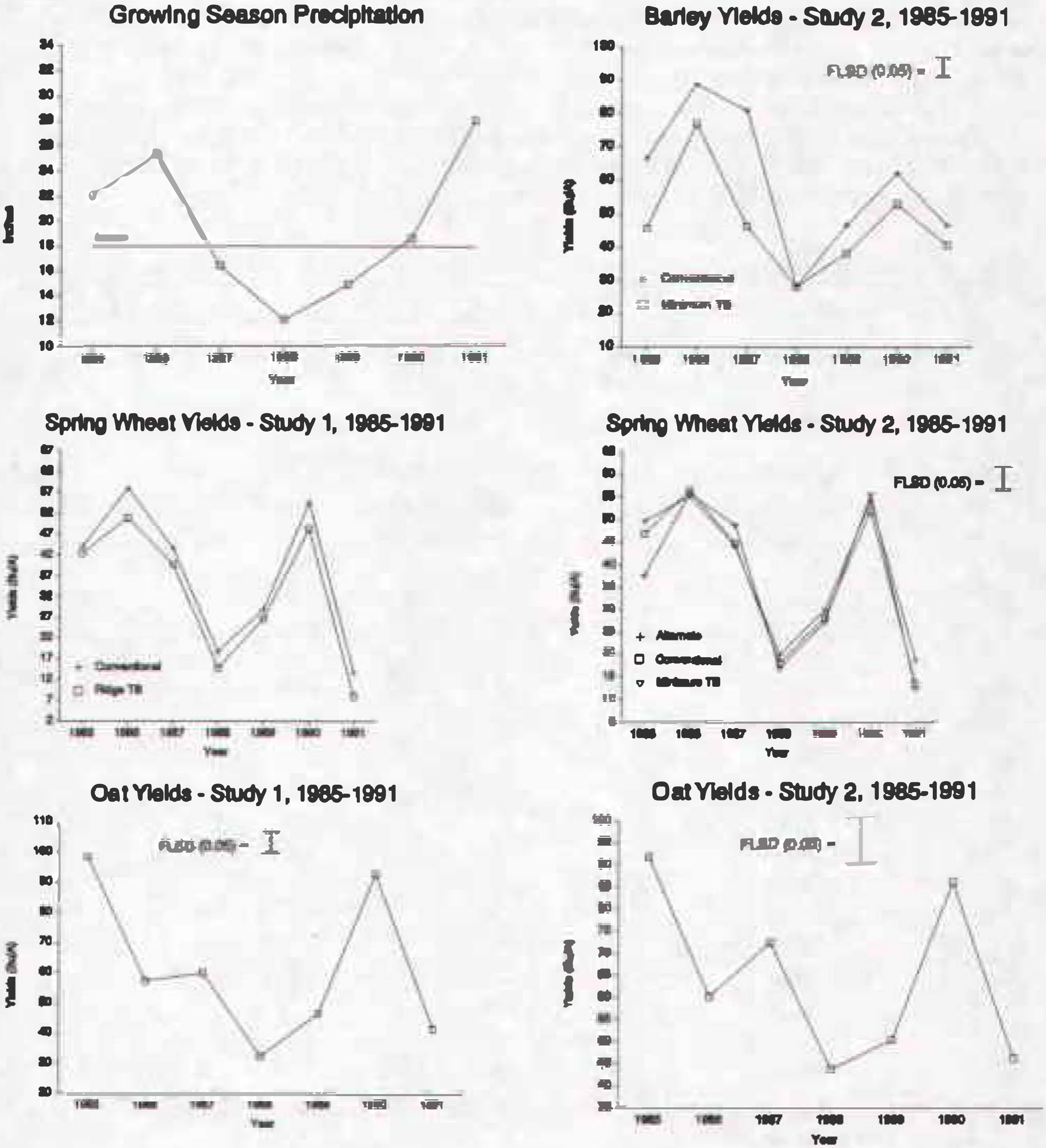


Figure 4. Growing season precipitation and small grain yields, 1985-1991.

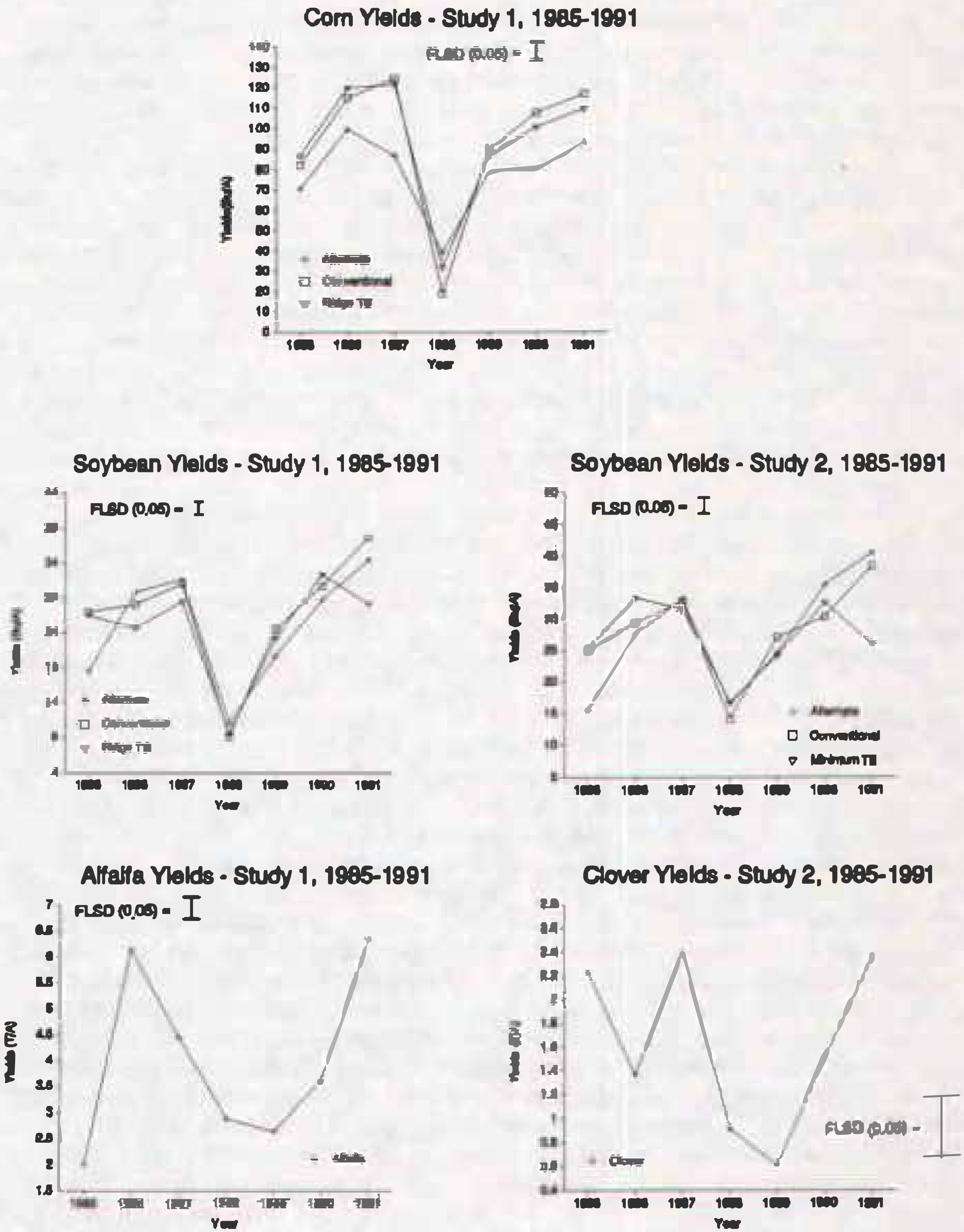


Figure 5. Row and forage crop yields, 1985-1991.

PRODUCTIVITY OF SYSTEMS, 1985-1991

One of the objectives in using larger-than-normal size plots in these studies was an attempt to obtain more realistic yield data. Based on conversations with neighboring farmers over the course of this study, we have found that crop yields in these studies have been very comparable to their yields on farms with soil types similar to those at the NE Station. We are thus more comfortable in scaling results in these studies up to a farm-size basis.

Results presented in Tables 27-29 and in Figs. 4 and 5 are expressed on a per acre basis. These types of yield comparisons are only one method of comparing productivity, and can be misleading when different crops and lengths of rotations are involved in comparisons. Another measure of productivity is the total plant material (grain and/or forage) or biomass removed from the various systems over the past seven years. Figure 6 compares biomass removed both on a yearly and cumulative basis. These estimates are based on a 540 acre farm with set-aside met each year. In Study I the Alt system has out-produced the Conv and R-T systems, and on a cumulative basis the gap appears to be widening. It is interesting to note that the greatest differences in productivity between the Alt system and the Conv and R-T systems occurred in years with abnormal precipitation, i.e. 1986 and 1991 were well above normal in precipitation and 1988 was well below. A major reason productivity was higher in the Alt system was the inclusion of a forage-legume (alfalfa) in the rotation.

An area of possible concern is what appears to be a gradual decline in the productivity of the R-T system compared to the Conv, particularly the past 2 years (Fig. 6). The R-T system has required higher inputs of both fertilizer and herbicides (Table 31), and these higher inputs coupled with sometimes lower productivity have influenced economic returns (Table 35). The inclusion of a small grain crop (spring wheat) in the R-T system rotation has complicated tillage and planting operations in this system. The spring wheat was included because small grains are an important component of the crop mix in northeastern SD. Also, it should be remembered that these are experimental studies, and one of the purposes of a research station is to identify potential problems that might occur with various systems of crop production.

Total yields for individual crops, and the nutrients and herbicides applied over the seven-year period in Study I are compared in Table 31. The amount of corn produced in the Alt system on a farm-scale basis was 33% less than in the Conv and R-T systems. A major portion of the reduction is explainable by the lesser number of acres planted (-21%) to corn each year in the Alt system (see footnote in Table 31). The lower number of acres planted to soybeans in the Alt system would also explain most of the 21-25% reduction in soybean production compared to the Conv and R-T systems. Although both corn and soybean production was less in the Alt system, the total biomass (plant material) removed from the system was approximately 50% greater than the Conv and R-T systems. Again, alfalfa was a major contributor to the higher biomass production. Approximately twice as much nitrogen was applied in the Conv and R-T systems compared to the Alt, and these systems also received about 10 times as much herbicide (Table 31). The diesel fuel equivalents are included for the manufactured N applied in the Conv and R-T systems as a guide to the amount of energy required to produce and transport N fertilizer. These equivalents are based on research at Iowa State University that indicates the energy equal to that in a gallon of diesel fuel is required to produce and transport each 4.2 pounds of N. The corn in the Conv and R-T systems received a major portion of the N applied. Part of the reason the energy output/input ratio is close to one when ethanol is produced from corn is the substantial amount of energy required to produce corn under our current production systems.

In Study II the productivity of the Alt system has generally been less than the Conv and M-T (Fig 6), although in the 1988 drought year the productivity was nearly equal in all systems. Small grains are a major part of the crop mix in the systems in Study II, and Fusarium Head Scab greatly reduced the productivity of all the systems in 1991. Relative to inputs of fertilizer and herbicide (Table 32), the productivity of the Alt system was remarkably high. Apparently the clover (green manure) crop was an adequate substitute for the more traditional inputs in the other systems. Total soybean production was approximately 16% lower in the Alt system compared to the Conv and M-T systems, and spring wheat production was 10% lower. It appears the primary reason productivity was lower on a farm-scale basis in this Alt system was the 16% fewer acres planted to a particular crop (see footnote, Table 32). The productivity of the M-T system has generally been less than the Conv system in spite of substantially higher inputs of both fertilizer and herbicides (Fig. 6 and Table 32). These higher inputs have reduced economic returns in this system (Table 35).

Another long-term objective of these studies is to investigate the possible effects if alternative-type systems were to be more widely adopted. One of the questions concerning these types of legume-based systems is how the increased amount of alfalfa produced would be utilized. Currently the principal use of alfalfa is for livestock feed, primarily ruminant livestock. Also, 70 to 80% of the corn produced in the U.S. is reportedly fed to livestock. Table 33 compares the total corn and alfalfa produced, on a farm-scale basis, in Study I over the seven year period. As indicated earlier, corn production was substantially higher (+51%) in the Conv. and R-T systems, however, in terms of dry matter produced the Alt system was more than twice as productive (+108%). Assuming both products were fed to ruminant livestock, the total digestible nutrients (TDN) produced in the Alt system was 53% higher than in the Conv and R-T. The alfalfa TDN was equivalent to 91,413 bu of corn, which would more than make up for the reduced amount of corn produced in the Alt system.

Protein produced in the Alt system was 208% higher than in the Conv and R-T. This amount of protein would likely substitute for the reduced amount of soybean meal available due to the lower soybean production in the Alt system. Ruminant livestock feed is not the only use for alfalfa. Studies in Iowa indicate alfalfa could comprise 25% of the diet for market swine and up to 96% of the diet for gestating sows.

Overall, it appears that Alt systems would provide adequate amounts of livestock feed. However, widescale adoption of these types of systems would likely have a major influence on how livestock is produced. Alfalfa is a bulky commodity and is expensive to transport compared to corn, thus, it would be most efficient to utilize it near where it is produced. This would mean an increase in on-farm produced livestock as opposed to the current large-scale confinement feeding operations. Large-scale feeding operations currently are more competitive due in part to low corn prices. The reduced output of corn in Alt systems would likely result in substantially higher corn prices and thereby tend to make on-farm produced livestock more cost competitive. Increased numbers of livestock on farms would also facilitate the return of nutrients to the land through manure additions.

The addition of livestock to more farming operations would increase labor requirements, and therefore could increase jobs in the farm sector. One approach to adding livestock to an operation, assuming several neighboring farms utilized alternative systems, might be for several farmers to hire a herdsman and rotate the livestock operation from farm to farm. This approach would reduce disease problems associated with continuous livestock production and would aid in returning livestock manure to each of the systems.

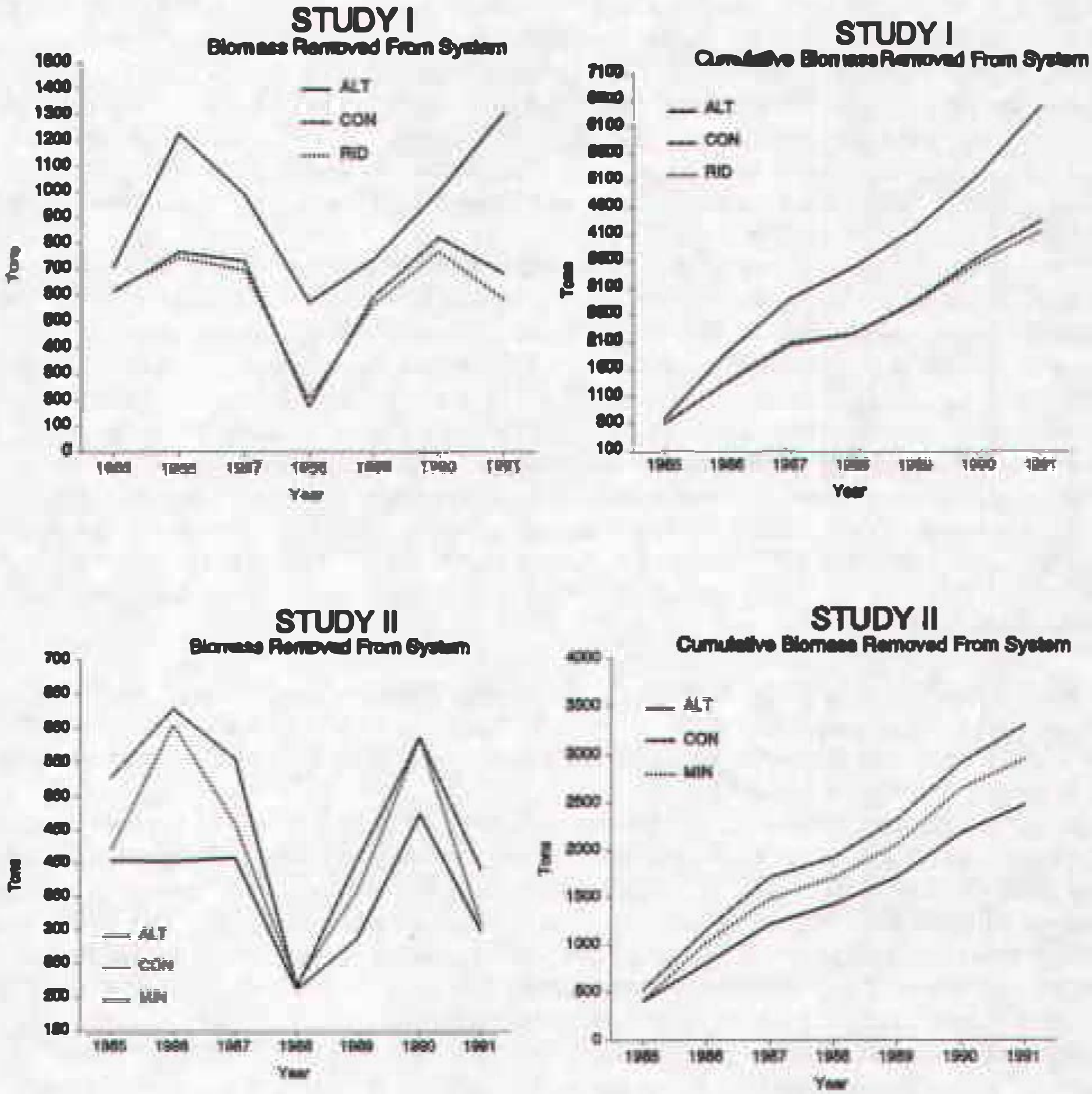


Figure 6. Total plant material (biomass) removed from systems, 1985-1991. Assumes farm with 540 crop acres and set-aside met each year.

Table 31. Total yields, and nutrients and herbicides applied, 1985-1991, Study I -- Assuming a 540-acre farm with set-aside met each year.*

			Total Nutrients Applied (lbs)			Herbicides
System	Crop	Yield	N	P	K	(active ingredient)
Alt	Corn	69,655 Bu				
	Soybean	22,209 Bu				
	Oats	54,466 Bu				
	Alfalfa	3,540 Tons				
			85,738[a]	26,083	98,595	384 lbs[b]
	Biomass Removed (dry wt)	13,051,718 lbs[c]				
Conv	Corn	105,229 Bu				
	Soybean	30,362 Bu				
	Spring Wheat	42,004 Bu				
			162,211 38,627 gal[d]	5,289	--	3,505 lbs
	Biomass Removed (dry wt)	8,756,941 lbs				
R-T	Corn	105,265 Bu				
	Soybean	27,843 Bu				
	Spring Wheat	36,883 Bu				
			177,897 42,356 gal[d]	5,289	--	4,188 lbs
	Biomass Removed (dry wt)	8,359,838 lbs				

[a]Applied as feedlot manure to oat/alfalfa in fall of each year.
[b]Eptam applied to clear-seeded alfalfa in initial year (1985) of study.
[c]Total dry weight of plant material (grain and/or forage) removed from system over seven-year period. Assumes corn at 15.5% moisture and soybeans and small grains at 13% moisture.
[d]Diesel fuel equivalent of commercial N applied - see text.
The average number of acres planted to a particular crop over the seven-year period with set-aside met would be: Alternate = 127, Conventional and R-T = 160. (The actual acreage each year varied somewhat with changes in set-aside requirements.)

Table 32. Total yields, and nutrients and herbicides applied, 1985-1991, Study II -- Assuming a 540-acre farm with set-aside met each year.*

System	Crop	Yield	Total Nutrients Applied (lbs) N	P	K	Herbicides (active ingredient)
Alt	Soybean	26,084 Bu				
	Spring Wheat	36,720 Bu				
	Oats	60,899 Bu				
	Clover	(green manure)				
			5,940[a]	1,393	6,102	405 lbs[b]
	Biomass Removed (dry wt)	4,973,797 lbs[c]				
Conv	Soybean	31,534 Bu				
	Spring Wheat	41,498 Bu				
	Barley	67,183 Bu				
			114,692 27,308 gal[d]	6,733	--	2,535 lbs
	Biomass Removed (dry wt)	6,617,833 lbs				
M-T	Soybean	30,516 Bu				
	Spring Wheat	40,680 Bu				
	Barley	52,860 Bu				
			163,704 38,977 gal[d]	6,733	--	4,396 lbs
	Biomass Removed (dry wt)	5,923,865 lbs				

[a]Applied as feedlot manure to oat/clover in initial year (1985) only.
[b]Eptam applied to clear-seeded clover in 1985 only.
[c]Total grain (dry weight basis) removed from system over seven-year period. Assumes soybeans and small grains at 13% moisture.
[d]Diesel fuel equivalent of commercial N applied - see text.
*The average number of acres planted to a particular crop over the seven-year period with set-aside met would be: Alternate = 135, Conventional and M-T = 160.

Table 33. Total Corn and Alfalfa Production - Study 1, 1985-1991. Assume 540 A farm, set-aside met, both products fed to ruminant livestock.

	Alt	Conv	R-T
Corn (bushels)	69,655	105,229 +51%[a]	105,265 +51%
Alfalfa (tons)	3,540	--	--
Dry Matter (lbs)	10,376,075 +108%[b]	4,979,436	4,981,140
Total Digestible Nutrients (TDN) (lbs)[c]	6,860,468 +53%[b] (alfalfa TDN = 91,413 Bu Corn)	4,481,492	4,483,026
Protein (lbs)	1,533,208 +208%[b]	497,944	498,114

[a] Percent increase compared to Alt
[b] Percent increase compared to Conv and R-T
[c] Assumes corn 90% TDN, alfalfa 55% TDN (J. Wagner, Pers. Comm.)

PRELIMINARY PROFITABILITY COMPARISONS FOR FARMING SYSTEMS TRIALS AT SDSU'S NORTHEAST STATION IN 1991 CROP YEAR

D.L. Becker and T.L. Dobbs[1]

This brief report constitutes a preliminary profitability analysis for the 1991 Farming Systems trials at SDSU's Northeast Research Station. Some checking of the enterprise and whole farm budgets was still underway at the time the annual report was being prepared in December 1991, so final estimates could differ slightly from those reported here. The economics research reported here has been supported by SDSU Agricultural Experiment Station Projects No. H-076 and No. H-191 and by U.S.D.A. Low-Input/Sustainable Agriculture (LISA) Grant LI-88-12.

The details of various cultural practices and crop yields for each farming system in Studies I and II at the Northeast Station can be found elsewhere in this annual report. Extensive use was made of those yields and cultural practices in developing the 1991 crop enterprise budgets.

Federal farm program provisions (target prices, loan rates, set aside requirements) and estimated crop product selling prices and Federal deficiency payment levels used in our budget calculations for the 1991 crop year are shown in Table 34. With the "Triple Base" farm program introduced in the 1991 crop year, farmers could not receive deficiency payments on 15 percent of each crop's program base--the so-called "Normal Flex" acres. Also, of course, deficiency payments could not be received on the required set aside acres. No selling price was assigned to clover in the alternative system of Study II, because the clover is not harvested. Fertilizer and herbicide prices were updated to 1991 levels in the enterprise budgets. Nitrogen fertilizer was priced at $0.21/lb (in dry form).

Preliminary cost and profitability comparisons are shown in Table 35. The first five columns show direct (operating) costs other than labor, gross income, and three measures of profit or net income for each farming system, on a per-acre basis. The sixth (last) column shows one of the net income measures--net income over all costs except management--on a whole farm basis, assuming a farm with 540 tillable acres

The alternative farming system was the most profitable of the three systems in Study I in 1991, by any of the three net income measures (Table 35). Direct costs for that system were lowest, as has been the case every year. Gross income was the highest for the alternative system in 1991; this has happened in only one previous year (1988) since the Farming System studies were started in 1985. The combination of low direct costs and high gross income caused the alternative system to be most profitable, even when labor and other costs (such as machinery depreciation) were included. Net income over all costs except management for the alternative system ($51/acre) was roughly double that of the conventional system ($25/acre) in 1991. The ridge till failed to cover "all costs except management".

Benefiting the Study I alternative system in 1991 were high alfalfa yields. Three cuttings of alfalfa on the acreage seeded the previous year plus one cutting (following harvest of the oats

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nurse crop) on the acreage seeded in 1991 resulted in 6.34 tons per acre of the "second year alfalfa". (Since a hay cutting normally is not taken at the Northeast Station during the year alfalfa is seeded, we've shown the yields here on the basis of the acreage normally harvested--i.e., the acreage in the second year, the year following seeding with oats.) Thus, even though alfalfa hay prices ($40/ton) were considerably lower than in the past few years, gross income for the alternative system was the highest it has been since this study started. Net income over all costs except management for the alternative system was the second highest it had ever been (it was slightly higher in 1990).

The conventional and ridge till systems in Study I, on the other hand, suffered from very poor wheat yields in 1991. Reasons for that are discussed elsewhere in this annual report. Wheat yields were even worse in the ridge till system than in the conventional system, and soybean yields were lower in the ridge till system than in either the conventional or the alternative system. Although corn yields on the ridge till system were higher than in the alternative system, they were slightly lower than in the conventional system. Due to this comparatively weak yield performance and to higher direct costs than in the other systems, the ridge till system had the lowest net income of the three systems in Study I.

The conventional and alternative systems of Study II were almost equally profitable--by any of the three net income measures--in 1991, and the minimum till system was least profitable (Table 35). The alternative system had lower gross income than the conventional system, but that was partially offset by lower direct costs. The minimum till system had the highest direct costs and the lowest gross income of the three systems, resulting in negative estimates of net income (i.e., losses, rather than profits). The low gross income of the minimum till system in 1991 is attributable to that system having (1) substantially lower soybean yields than either the alternative or the conventional system, (2) wheat yields that were several bushels lower than the alternative system and slightly lower than the conventional system (wheat yields of all systems were very poor), and (3) lower barley yields than the conventional system.

Table 34. Assumptions about Federal Farm Program and Market Prices Used in the 1991 Budgets.

Crop	Assumption
Corn	
Codington County loan rate ($/bu.)	1.52
Target price ($/bu.)	2.75
Acreage reduction program (%)	7.5
Normal Flex Acreage reduction (%)	15.0
Deficiency payments ($/bu.)	.40*
S.D. selling price ($/bu.)	2.15*
Spring Wheat	
Codington County loan rate ($/bu.)	2.04
Target price ($/bu.)	4.00
Acreage reduction program (%)	15.0
Normal Flex Acreage reduction (%)	15.0
Deficiency payments ($/bu.)	1.10*
S.D. selling price ($/bu.)	2.85*
Oats	
Codington County loan rate ($/bu.)	.76
Target price ($/bu.)	1.45
Acreage reduction program (%)	0
Normal Flex Acreage reduction (%)	15.0
Deficiency payments ($/bu.)	.30*
S.D. selling price ($/bu.)	1.10*
Barley	
Codington County loan rate ($/bu.)	1.21
Target price ($/bu.)	2.36
Acreage reduction program (%)	7.5
Normal Flex Acreage reduction (%)	15.0
Deficiency payments ($/bu.)	.41*
S.D. selling price ($/bu.)	1.75*
Soybeans	
Codington County loan rate ($/bu.)	4.68
S.D. selling price ($/bu.)	5.25*
Alfalfa	
S.D. selling price ($/ton)	40.00*

*Estimates for marketing year.

Table 35. Preliminary results of farming systems analyses based upon 1991 yields, farm program, and prices.

	Dollars/Acre					
			Net Income Over			
System[a]	Direct Costs Other Than Labor	Gross Income	All Costs Except Land, Labor, and Management	All Costs Except Land and Management	All Costs Except Management	Whole Farm, Net Income Over All Costs Except Management[b] ($)
Farming Systems Study I						
1. Alternative (oats-alfalfa-soybeans-corn)	49	175	89	77	51	27,427
2. Conventional (corn-soybeans-s. wheat)	70	164	61	51	25	13,765
3. Ridge Till (corn-soybeans-s.wheat)	76	139	31	22	-4	-2,296
Farming Systems Study II						
1. Alternative - (oats-clover-soybeans-s.wheat)	31	89	33	25	-1	-688
2. Conventional (soybeans-s.wheat-barley)	44	111	35	26	0	-205
3. Minimum Till (soybeans-s. wheat-barley)	58	87	-1	-9	-35	-19,139

[a]Crops are shown in the order in which they occur in each rotation.
[b]For farm with 540 tillable acres. Figures in this column are equivalent to 540 multiplied by "prerounded" figures in the "all costs except management" column.

SOIL AND PLANT TISSUE PARAMETERS FOR FARMING SYSTEMS STUDIES

H.J. Woodard, D. Winther and D.A. Claypool

Methods

Fertilizer N was applied as ammonium nitrate on the surface of the conventional, ridge-till and minimum-till plots in the spring. The N rate was determined from soil test recommendations based upon the residual NO_3-N (0-24") sampled in the fall of 1990, and the nutrient demand from expected yield goals for all crops. Yield goals of 100 bu/A for corn, 100 bu/A for oats, 80 bu/A for barley, 50 bu/A for spring wheat and 40 bu/A for soybeans were established to calculate nutrient demand for the 1991 crops. The 1990 soil test levels for P and K were determined to be adequate to support the yield goals for the 1991 crops. All other nutrients were considered adequate as well.

Plant tissue was sampled from two, 1 m length, rows from the small grain plots at Feekes stage 5 just prior to jointing. Twenty corn shoots were sampled at the 6th leaf stage (V6) of growth from each treatment plot. Upper trifoliate soybean leaves were sampled from 25 plants at early bloom stage for nutrient analysis. Plant tissue was sampled from all 4 treatment replications. The samples were dried at 65-70° C for 3 days, weighed and ground to pass through a 40 mesh sieve before submission to the soil testing lab for analysis.

Soils in each treatment plot of both farming systems studies were sampled in the fall of 1991 following crop harvesting. A tractor with a rear-mounted hydraulic soil sampling probe extracted 4 samples randomly from each of the treatment plots and all 4 treatment replications. Depth increments of 0-6" and 6-24" each were sectioned from the 1" cores, mixed well and subsampled for soil moisture content. A subsample of the moist soil was weighed and placed in a drying oven at 105°C for three days. The dry sample was weighed and total moisture was determined gravimetrically. The remaining portion of the sample was air-dried and ground for submission to the soil testing lab for analysis.

All soil and plant samples were analyzed at the South Dakota State Soil and Plant Analysis Laboratory according to the standard procedures of the NCR-13 committee.

Results and Discussion

The mean total soil moisture did not vary between any of the tillage systems or between crops in the farming system I study for the two depths (Table 36). However, the range of soil moisture difference in the 6-24" depth was 0.5-2.0% lower than in the upper depth for all tillage treatments and crops. A precipitation event of .34" on September 24 before harvest and sampling, replenished some evapo-transpirational moisture losses in the upper depth. However, this rainfall level was not significant enough to replenish moisture from crop removal and evaporation in 6-24".

Significant differences in mean total soil moisture among tillage systems and crops were measured in farming system II (Table 37). Total soil moisture was 6.9% higher in the minimum tillage system than in the conventional tillage treatment in the 0-6" depth. The higher moisture level may be attributed to lower evaporation from slightly more residue cover from previous crops, and lower transpirational demands due to lower yields (elsewhere in this report).

The total soil moisture in the barley plots was also significantly higher than the moisture in the clover plots in the 0-6" depth in farming system II (Table 37). Barley was the first crop harvested in the summer. The period between harvest and soil sampling for moisture determination was greater in the barley plots than in other plots. This longer fallow period allowed more moisture to accumulate in the upper soil depth than in plots of the crops which were harvested later in the summer. The surface moisture of plots, especially those of the soybeans and the double-crop oats/sweet clover system which were harvested later, was still being utilized in the transpirational needs of the crop as the fallow barley plots were accumulating moisture. There were no significant differences in the mean total soil moisture in any of the plots among the tillage systems or crops for the 6-24" depth in farming system II (Table 2). The differences between surface soil moisture and moisture in the 6-24" depth for tillage and crops were less as they were in the farming system I study. Total soil moisture varied from 1.2-9.3% between tillage systems for the same crop within the 0-6" depth.

Table 36. Mean total soil moisture sampled after harvest in two depths for tillage and cropping systems in Farming System I Study.

Tillage	Total Moisture		Crop	Total Moisture	
	0-6"	6-26"		0-6"	6-26"
	---------- % ----------			---------- % ----------	
Alternate	15.6 a	14.0 a	Alfalfa	15.3 a	14.4 a
Conventional	15.4 a	15.8 a	Corn	16.4 a	15.9 a
Ridge-Till	15.7 a	14.8 a	Oats/Alfalfa	15.0 a	13.0 a
			Soybeans	14.8 a	14.2 a
			Spring Wheat	16.0 a	15.3 a

Mean moisture levels with the same Duncan's mean range comparison test letter of significance comparing tillage systems or crops within the same soil moisture depth are not significant at the α = .05 level.

Table 37. Mean total soil moisture sampled after harvest in two depths for tillage and cropping systems in Farming System II Study.

Tillage	Total Moisture		Crop	Total Moisture	
	0-6"	6-26"		0-6"	6-26"
	---------- % ----------			---------- % ----------	
Alternate	16.2 a	15.6 a	Barley	24.8 a	15.5 a
Conventional	17.5 a	14.9 a	Clover	20.6 ab	17.9 a
Minimum-Till	24.4 b	16.4 a	Oats/Clover	14.4 b	12.1 a
			Soybeans	16.1 ab	15.3 a
			Spring Wheat	18.2 ab	17.0 a

Mean moisture levels with the same Duncan's mean range comparison test letter of significance comparing tillage systems or crops within the same soil moisture depth are not significant at the $\alpha = .05$ level.

Soil NO_3-N was generally higher in the 6-24" depth than in the 0-6" depth for crops in the same tillage system (Tables 38 and 39). This effect was probably due to the higher removal of available N at the surface where presumably the greatest number of roots occur for most crops. In addition, it is possible that some leaching of the surface applied NO_3-N occurred during the high rainfall periods of the spring and early summer. Soil NO_3-N levels at the 6-24" depth were generally higher for corn in conventional and ridge-till tillage system (farming system I) and for spring wheat in conventional tillage (farming system II) compared to crops in the alternate system at the same depth. Since the only nutrient amendment applied to the alternate system was a manure application in the fall of 1990, the higher NO3-N at the 6-24" depth in the conventional system probably represents N from unused fertilizer.

Grain yields for corn (Table 28) in the Conv and R-T systems were near the expected yield goals established before fertilizer N was applied. Theoretically, the residual N level should be low if yield goals were achieved. The soil test N recommendation for fertilizer applications accounts for nutrient N contributed from prior legume crops and residual soil NO_3-N levels. Since the reliability of the SD soil test recommendation for N applications has been demonstrated, the large amount of residual soil NO_3-N measured in the corn plots from the conventional and ridge-till system in the 6-24" depth probably represents an unaccounted source of N, such as from mineralization. The source of this mineralized N probably came from the decomposition of native organic matter and buried crop residues from previous cropping seasons.

The levels of soil NO_3-N in the conventional and ridge-till system for spring wheat in farming system I (Table 38) and for barley in the minimum-till system in farming system II (Table 39) were also at elevated levels compared to the alternate system in the 6-24" depth. The 1991 grain yields (elsewhere in this report) for these crops were about half the yield goal levels established for N fertilizer applications. These levels of NO_3-N in 6-24" represent in part, the residual N fertilizer which was available to produce a crop of a greater grain yield but which was not utilized.

Organic matter and pH levels are close to the levels observed last year in all tillage systems and crops (Tables 50 and 51; 1990 Progress Report, NE Research Farm). A short term response to changes influenced by crop rotations for these parameters would not be expected. In addition, there are no clear differences among tillage systems and crops for these two parameters after 7 years of cropping (Previous Progress Reports).

Table 38. Soil test results from Farming Systems I.

System/Crop	NO_3 0-6"	NO_3 6-24"	Organic Matter	P (0-6")	K (0-6")	pH
	lbs/A	lbs/A	%	lbs/A	lbs/A	
Alternate						
Oat/Alfalfa	4	13	3.5	19	335	6.5
Alfalfa	27	37	3.2	23	300	6.4
Soybean	19	27	3.5	21	275	6.2
Corn	6	15	3.1	13	307	6.8
Conventional						
Corn	6	54	3.1	21	362	6.5
Soybean	9	38	3.1	21	325	6.4
Sp. Wheat	27	35	3.1	18	325	6.4
Ridge-Till						
Corn	19	61	3.3	14	300	6.2
Soybean	11	21	3.3	21	290	6.1
Sp. Wheat	32	34	3.5	26	315	6.2

The soil test K levels were slightly lower than the levels observed for 1990 across all tillage and crops for both farming systems. A lower level in 1991 would be expected as these plots continued to be cropped without any replacement of K from fertilizer applications. However, these levels will be high enough to support reasonable yield goals in 1992 without fertilizer K applications. Also, manure added in the Alt System I contributes significant amounts of K to that system.

Table 39. Soil test results from Farming Systems II.

System/Crop	NO_3 0-6"	NO_3 6-24"	Organic Matter	P (0-6")	K (0-6")	pH
	lbs/A		%	lbs/A		
Alternate						
Oat/Clover	4	12	3.8	16	317	6.1
Clover	46	53	3.5	22	330	5.9
Soybean	14	80	3.7	23	307	6.2
Sp. Wheat	10	15	3.3	16	305	6.2
Conventional						
Soybean	10	40	3.2	21	302	6.3
Sp. Wheat	36	50	3.3	20	312	6.0
Barley	27	42	3.2	17	317	6.2
Minimum						
Soybean	13	37	3.7	19	292	5.8
Sp. Wheat	19	19	3.3	18	305	6.3
Barley	23	63	3.4	15	317	6.2

There was only a small variation of soil test P levels among tillage and crops (Tables 38 and 39). The range for soil P was 15-23 lbs/A and generally considered to be at a 'medium' soil test status. However, there is a striking difference between these soil test P levels and the 1990 soil P levels from these plots. The soil test levels in 1991 are about half of the levels of the 1990 sampling. From 1987 to 1990, there had been a gradual decrease in soil test P levels after a sudden drop from the 1985 P levels (1990 Research Report, NE Research Farm. This decrease of soil P in 1991 was about 50% overall from the 1990 levels and was not consistent with the trend of gradually lower soil test P levels in prior years. A significant application of fertilizer P in the spring of 1992 would be required to correct a possible nutrient P deficiency that may occur in the 1992 crops in the conventional, ridge-till and minimum-till tillage systems if these soil test P levels are accurate. However, before corrective action occurs, some of the plots will be sampled again in the spring of 1992 to double-check the P status.

The response of corn shoot early dry matter production was significantly higher for the alternate system in farming system I (Table 40). It is possible that the late application of fertilizer N to the conventional and ridge-till tillage systems in 1991 may have restricted early season plant vigor. The mean soil test N level in the 0-6" depth for 1990 was 6.3 lbs/A which may have been low enough to affect growth vigor, however, this was only 3 lbs less than the alternate. There were no differences in the early shoot dry matter levels among systems in the small grains in the farming systems II study (Table 41). Apparently, the late fertilizer N application did not limit early dry matter growth in these crops in the conventional or minimum tillage systems compared to the alternate system.

Table 40. Response of mean early shoot dry matter for corn (V6 stage) and spring wheat (Feekes stage 5) in Farming Systems I Study.

	Crop	
Tillage	Corn	Spring Wheat
	—— g/sample/plot -----	
Alternate	163.9 b	-
Conventional	123.3 ab	32.0 a
Ridge-Till	103.4 ab	26.9 a

Mean early shoot dry matter yields which have the same Duncan's mean range test letter of significance comparing tillage systems within the same crop are not significant at the α = .05 level.

Table 41. Response of mean early shoot dry matter for spring wheat, barley and oats (Feekes stage 5) in Farming Systems II Study.

		Crop	
Tillage	Spring Wheat	Barley	Oats
		---------- g/2 m row/plot ----------	
Alternate	20.8 a	18.7 a	--
Conventional	17.3 a	17.4 a	--
Minimum-Till	22.3 a	--	19.7

Mean early shoot dry matter yields which have the same Duncan's mean range test letter of significance comparing tillage systems within the same crop are not significant at the α = .05 level.

Mean corn N concentration was significantly higher in the Conv system at the V6 stage and in the ear leaf compared to the Alt system in the farming system I study (Table 42). This is probably related to the significantly higher mean shoot dry matter observed in corn tissue sampled at the V6 stage in the Alt system plots (Table 40). Plant tissue P was highest in corn ear leaf tissue from the Conv system, and corn V6 and ear leaf plant tissue K was also highest in the conventional system compared to the alternate tillage system. Fertilizer P or K had not been applied to corn in the conventional or ridge-till system except for a 30 lbs P_2O_5/A starter application in 1988. Soil test P levels were roughly equivalent in all treatments (Table 38), and soil disturbance from tillage in the conventional and alternate system were similar. The application of fertilizer N was probably the only other factor that may have changed the plant growth and nutrient uptake potential (Table 40). Nutrient N availability was probably a limiting factor to corn growth in the alternate system.

Table 42. Response of corn, soybean, spring wheat and oat mean plant tissue nutrient concentrations to tillage system within crop and sampling period in farming system I study.

	Plant Tissue Concentrations		
Crop/Tillage System	N	P	K
	%		
Corn (V6 stage)			
Alternate	3.20 a	.36 b	2.80 a
Conventional	3.86 b	.41 b	4.29 b
Ridge-Till	3.10 a	.27 a	2.97 a
Corn (ear leaf)			
Alternate	2.54 a	.24 a	1.54 a
Conventional	3.50 b	.32 b	1.83 b
Ridge-Till	3.31 b	.24 a	1.47 a
Soybean (trifoliate			
Alternate	5.47 a	.29 a	1.35 a
Conventional	5.49 a	.34 a	1.59 b
Ridge-Till	5.47 a	.33 a	1.66 b
Spring Wheat (shoot)			
Alternate	--	--	--
Conventional	3.97 a	.32 a	3.09 a
Ridge-Till	3.77 a	.40 b	3.36 a
Oat (shoot)			
Alternate	2.93	.33	3.42

Mean nutrient concentrations which have the same Duncan's mean range test letter of significance comparing tillage systems within the same crop are not significant at the $\alpha = .05$ level.

Nutrient N and P concentrations were similar in soybean leaf tissue among all tillage systems (Table 42). Tillage disturbance in conventional system and alternate system as well as the soil test P levels were similar (Table 38). Since fertilizer N was not applied to soybeans, differences in plant vigor and subsequent N uptake would not be expected as in the corn crop. However, mean soybean plant tissue K from the alternate treatment was significantly lower than the plant K concentration in the conventional and ridge-till systems. Lower plant K levels might be related to the lower soil test K levels in the alternate system compared to the other systems.

Mean plant tissue N was slightly higher in the conventional system compared to the ridge-till system for barley, and higher in the conventional and minimum-till system compared to the alternate system for spring wheat in farming system II (Table 43). The N source in the alternate system was the previous green manure clover crop and soybeans. Since N was applied in an immediately available fertilizer form in the conventional and min-till system, higher plant tissue N levels in these systems were expected when compared to the alternate system where release of N from organic matter could occur over a longer period. There was no difference in the spring wheat plant tissue P and K levels among tillage systems.

Table 43. Response of barley, spring wheat and oat mean plant tissue nutrient concentrations to tillage system in farming system II study.

Crop/Tillage System	Plant Tissue Concentrations		
	N	P	K
		%	
Barley (shoot)			
Alternate	--	--	--
Conventional	4.53	.28	3.13
Min-Till	3.99	.37	3.36
Spring Wheat (shoot)			
Alternate	3.96	.36	3.25
Conventional	4.12	.34	3.10
Min-Till	4.29	.34	3.31
Oat (shoot)			
Alternate	2.65	.34	3.61

NUTRIENTS REMOVED FROM SYSTEMS, 1985-1991

The amounts of N, P and K removed from the systems, on a farm-scale basis, over the past seven years are compared in Table 44. In terms of nitrogen, the greatest disparity between removal and return appears to have occurred in the Alt system in Study I. However, a major portion of the N removed (approximately 2/3) was removed as alfalfa forage, and most of this N would have been supplied by the alfalfa through N fixation. In both Study I and II the reduced-till systems (R-T and M-T) have returned a greater proportion of the N removed compared to the Conv systems. In Study II the Conv system has returned only about 2/3 of the N removed (Table 44). Through the addition of livestock manure, the Alt system in Study I has returned a far greater proportion of the phosphorus removed than either the Conv or R-T systems. Also, the Alt system in Study I is the only system that returned an appreciable proportion of the K removed. The major portion of the P and K "returned" in the Alt system in Study II was in the form of green manure, and thus these nutrients were never removed from the system. However, some research data suggests that nutrients in green manure may be in a form more readily available for plant uptake.

Table 44. Nutrients removed from and returned to systems, assumes 540 A farm, set-aside met, 1985-1991.

System		lbs		
		N	P	K
Study I				
Alt	Removed:	384,788	41,024	208,657
	Returned:	107,947[a]	26,083	95,595
Conv	Removed:	234,328	36,610	71,454
	Returned:	192,573	5,289	0
R-T	Removed:	223,946	29,159	66,852
	Returned:	205,740	5,289	0
Study II				
Alt	Removed:	168,252	22,698	46,777
	Returned:	114,118	(8,333)[b]	(67,244)[b]
Conv	Removed:	219,136	27,401	61,456
	Returned:	146,226	6,733	0
M-T	Removed:	208,722	24,802	55,771
	Returned:	194,220	6,733	0

[a]N returned includes contribution of soybean, assumes 1 lb N/Bu.
[b]Includes nutrients "returned" as green manure (clover).

NEMATODE AND OLIGOCHAETE POPULATIONS

Populations of predaceous and microbial feeding nematodes at harvest were lower in most instances compared to 1990 (Figs. 7 and 8). In general, differences in populations of predaceous and microbial feeding nematodes between systems have not been consistent, however, the past three years populations of predaceous nematodes have been higher in the Alt and M-T systems compared to the Conv in Study II. Populations of Oligochaetes (tiny earthworms) were highest in the Alt systems in both studies in 1991. Pin nematode (Paratylenchus) numbers were also highest in the Alt systems.

Numbers of dagger nematodes (Xiphinema) remained significantly higher in the Alt and reduced-till systems in both studies, which continues the pattern observed the past 4-5 years (Figs. 7 and 8). Populations in Alt, R-T and M-T systems are currently at levels that may reduce plant growth. A preliminary greenhouse experiment was conducted in an attempt to measure the effect of Xiphinema on growth of corn and soybeans. Soil was removed from several plots with high populations of Xiphinema in fall, 1990. The soil was thoroughly mixed and one-half was steamed to eliminate nematodes. Equal amounts of soil were placed in pots and seeded with corn and soybeans. Each of the four treatments (check-corn, check-soybean, steamed-soil corn and steamed-soil soybean) were replicated four times. Two months later plants were removed and total dry weight was measured. Numbers of Xiphinema were also determined. Corn growth was reduced 16% in the nematode-infested soil. There was no growth reduction in soybean. Populations of Xiphinema nearly tripled over the course of the experiment on corn, and remained nearly constant on soybean. As mentioned, this was only a preliminary experiment, but it appears that corn is a good host for Xiphinema and that high populations can significantly reduce corn growth.

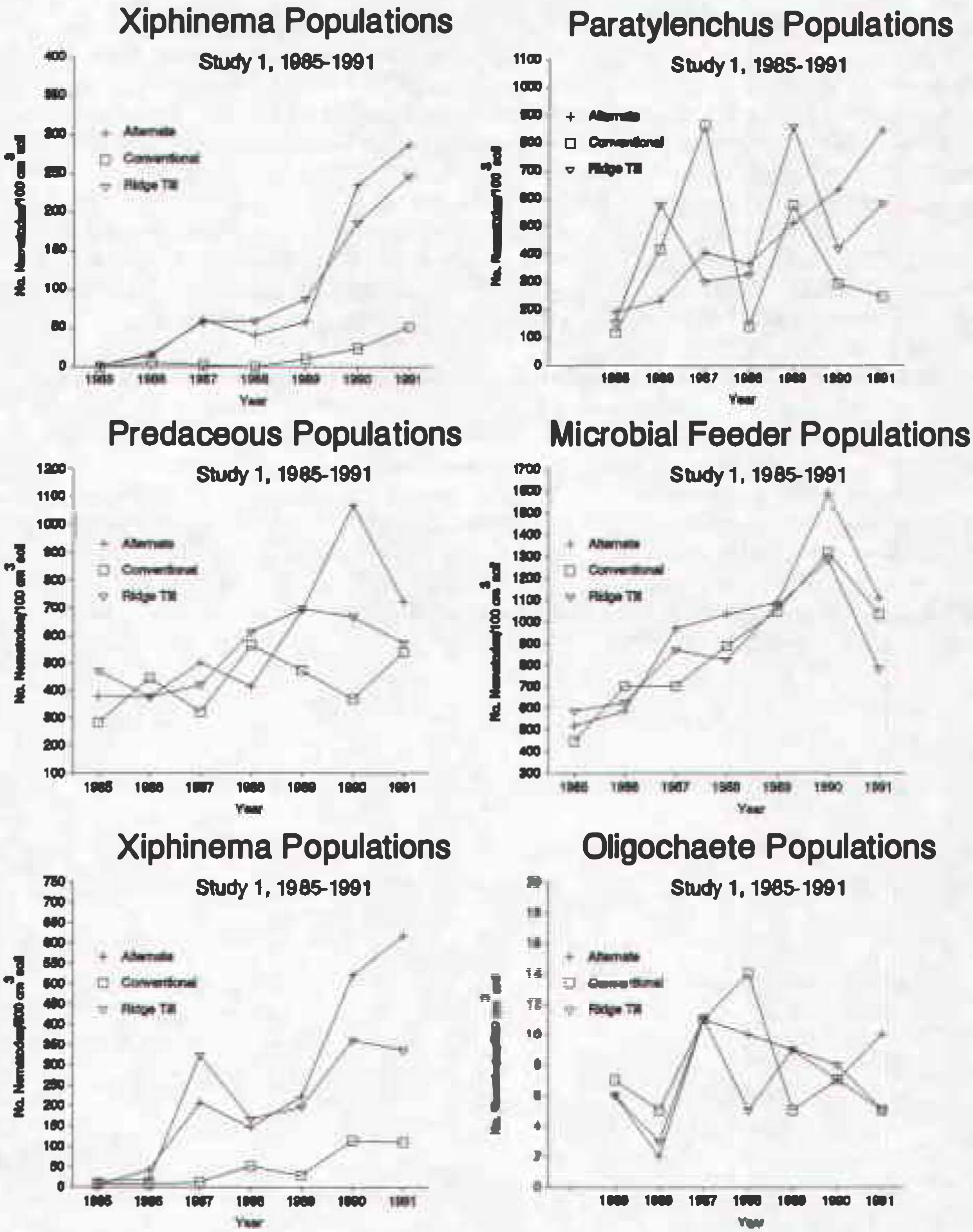


Figure 7. Nematode and Oligochaete populations in Study I, 1985-1991.

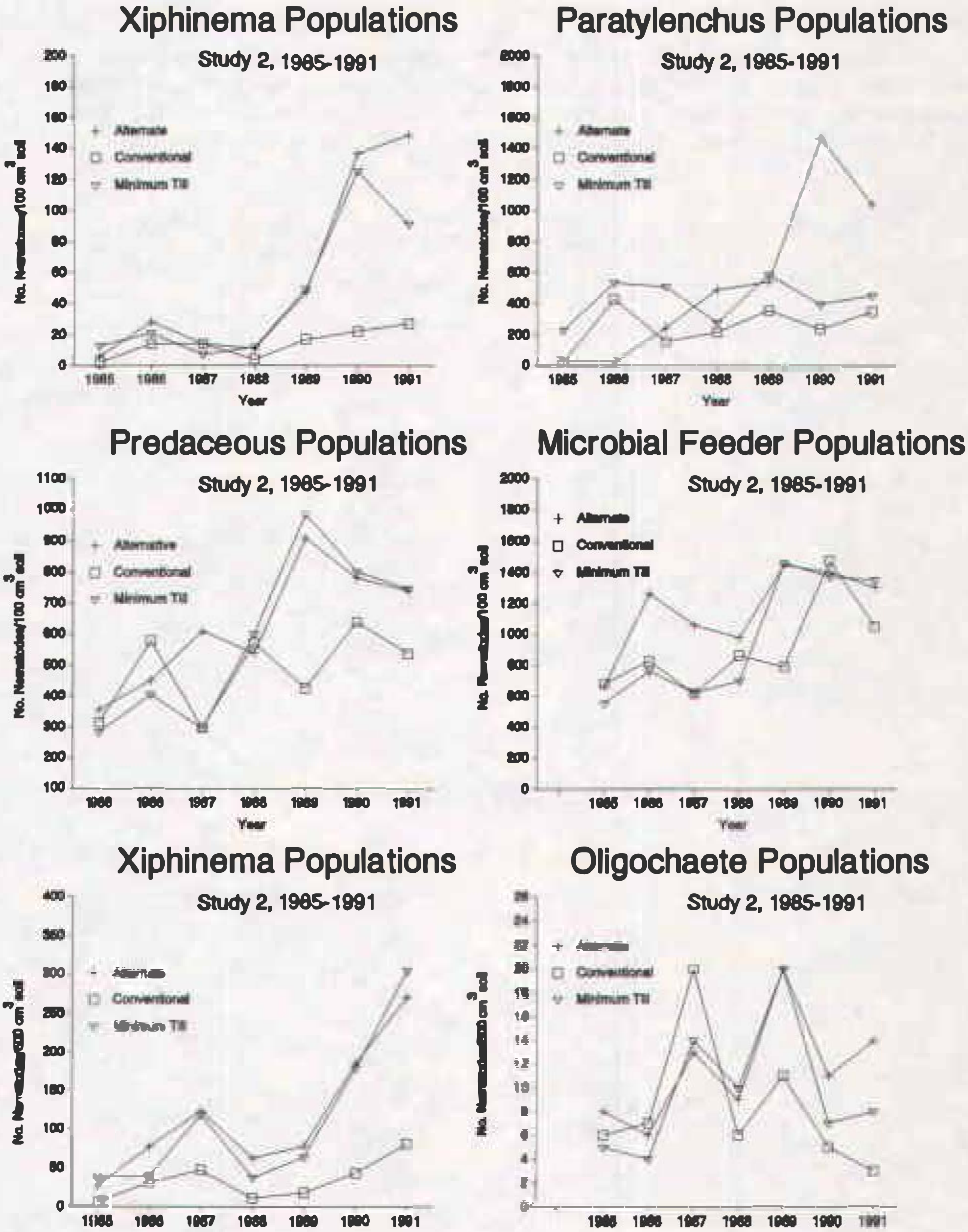
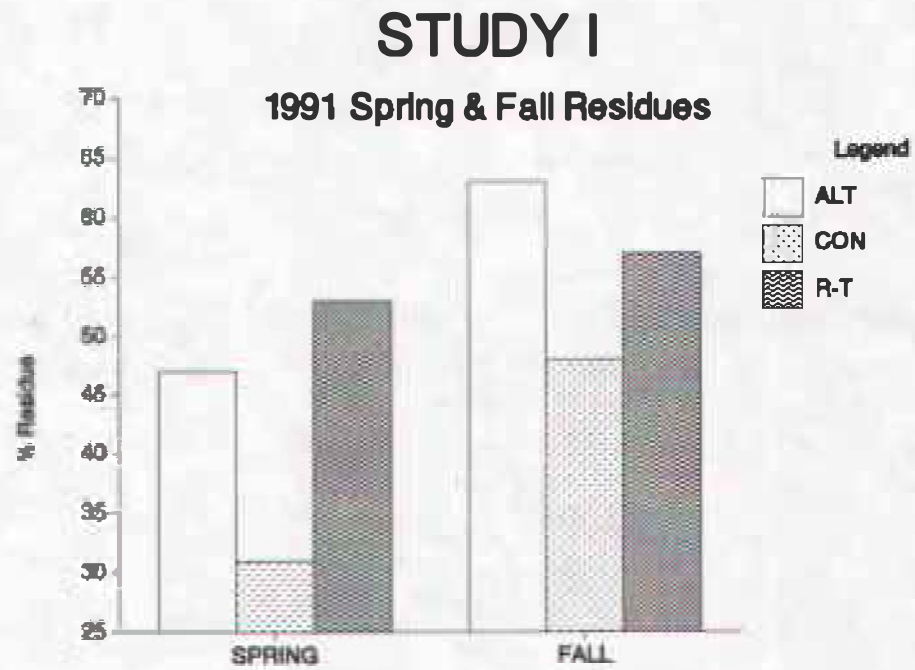
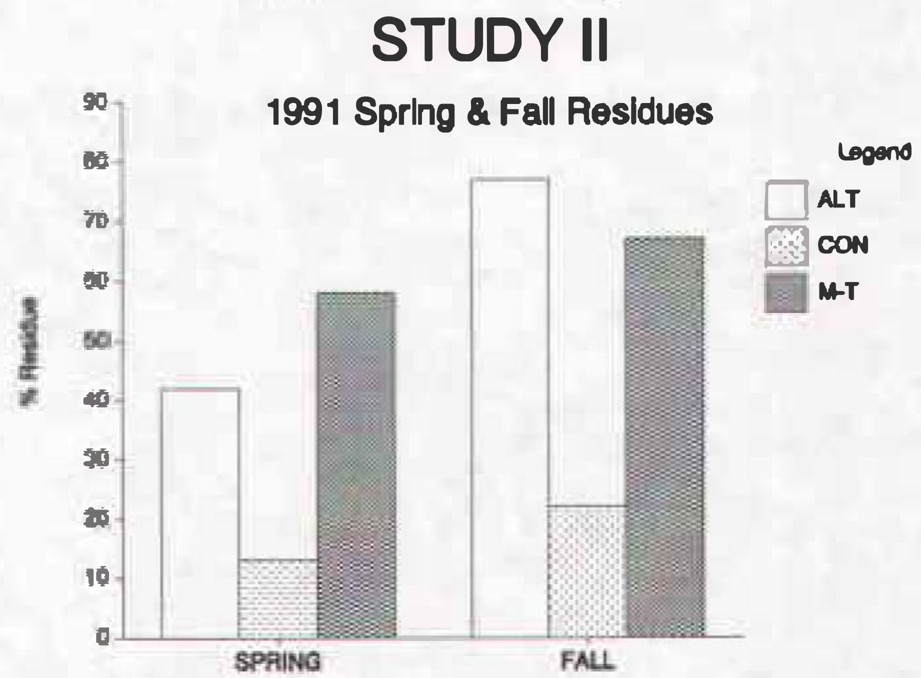


Figure 8. Nematode and Oligochaete populations in Study II, 1985-1991.

SURFACE RESIDUES, STUDY I AND II

The Alt and Reduced-Till systems in both studies provided greater protection of the soil surface than did the Conv (Fig. 9). In the fall of 1991, the surface residues averaged over all crops within a system were highest in the Alt systems in both studies. The Conv system in Study II includes considerable use of the moldboard plow and surface residues were well below 30% in both spring and fall.





WEED POPULATIONS, STUDY I AND II

In Study I, the highest numbers of foxtail occurred in the Alt system (Table 45). There was very little difference in broadleaf populations. Foxtail populations in soybeans were not substantially different between systems. Numbers of foxtail were 2 to 6 times higher in the R-T spring wheat compared to the Conv.

Populations of foxtail in spring wheat in Study II were highest in the Alt system (Table 46). Populations of annual broadleaves in spring wheat were higher in the Alt and M-T systems compared to the Conv. Weed populations in soybeans were very low in all systems. Foxtail populations were slightly higher in the Conv barley compared to M-T, while the reverse occurred for numbers of broadleaves.

Visual estimates of weed control were generally higher for the Conv and R-T systems in both studies (Table 47). The highest foxtail biomass in corn was measured in the Alt system. Based on results in the 1991 weed control study in corn (Table 21), the estimated yield losses due to foxtail were 11, 3 and 2 bushels in the Alt, Conv. and R-T systems, respectively. Foxtail biomass was also measured in soybean and results of a weed control study in soybeans (Table 22) indicated yield loss due to foxtail was low in all systems in both studies.

Table 45. Weed populations on 3 dates in Study I.

Study I	Alt	Conventional			Ridge-Till		
	8/13	6/11	7/16	8/13	6/11	7/16	8/13
CORN							
Foxtail[a]	82[d]	-	-	7	-	-	6
Annual Broadleaves[b]	8	-	-	9	-	-	8
Perennial Broadleaves[c]	1	-	-	1	-	-	3
SOYBEANS							
Foxtail	11	-	-	7	-	-	7
Annual Broadleaves	1	-	-	0	-	-	1
Perennial Broadleaves	3	-	-	0	-	-	0
SPRING WHEAT							
Foxtail	-	39	63	-	223	141	1
Annual Broadleaves	-	7	12	-	5	22	-
Perennial Broadleaves	-	0	2	-	0	3	-

[a]Foxtail includes both green and yellow.
[b]Annual Broadleaves primarily pigweed and Russian thistle.
[c]Perennial Broadleaves primarily dandelion.
[d]Number per 3 sq. ft.

Table 46. Weed populations on 3 dates in Study II.

Study II	Alternate			Conventional			Minimum-Till		
	6/11	7/16	8/13	6/11	7/16	8/13	6/11	7/16	8/13
SPRING WHEAT									
Foxtail[a]	47[d]	49	-	1	10	-	11	17	-
Annual Broadleaves[b]	40	34	-	9	15	-	27	45	-
Perennial Broadleaves[c]	0	3	-	0	0	-	0	3	-
SOYBEANS									
Foxtail	-	-	3	-	-	0	-	-	1
Annual Broadleaves	-	-	3	-	-	0	-	-	3
Perennial Broadleaves	-	-	0	-	-	0	-	-	1
BARLEY									
Foxtail	-	-	-	21	23	-	10	18	-
Annual Broadleaves	-	-	-	4	6	-	7	11	-
Perennial Broadleaves	-	-	-	0	0	-	0	3	-

[a]Foxtail includes both green and yellow.
[b]Annual Broadleaves primarily pigweed and Russian thistle.
[c]Perennial Broadleaves include dandelion and Canada thistle.
[d]Number per 3 sq. ft.

Table 47. Visual estimates of weed control in corn and soybeans and weed biomass, Study I and II.

Study 1	Alternate		Conventional		Ridge-Till	
	Corn	Soybean	Corn	Soybean	Corn	Soybean
Grass % Control:	55	72	78	94	78	84
Biomass (Grass)	521[a]	176	131	73	109	51
Broadleaf % Control	85	83	83	93	76	84
Biomass (Broadleaf)	3	134	48	0	51	26

Study 2	Alternate	Conventional	Minimimun-Till
	Soybean	Soybean	Soybean
Grass % Control	85	95	93
Biomass (Grass)	15	0	10
Broadleaf % Control:	88	94	86
Biomass (Broadleaf)	0	0	0

[a]Dry weight - lbs/A., grass biomass was primarily yellow foxtail.

DISEASE SUPPRESSIVENESS

The suppressiveness of spring wheat soil to several fungi was measured in Study I and II. Suppressiveness tests were conducted by adding soil from various test plots to soil artificially infested with the root disease pathogen under test, and determining the amount of preemergence seedling blight on two test plants, wheat and alfalfa. The level of disease was then compared with that which developed in the absence of the plot soil. The ratio between the two was considered to be a measure of the 'suppressiveness' or 'conduciveness' of the soil. A ratio greater than 1 indicates a suppressive soil, a ratio less than 1 indicates a soil that was conducive to the pathogen under test or which had its own pathogen in addition to the one under test. The pathogens used in these tests were *Fusarium graminearum*, cause of root rot of cereals, *Helminthosporium sativum*, cause of common root rot of wheat, and *Rhizoctonia solani* and *Pythium ultimum*, both of which cause seed decay and seedling blights of many plants.

In general there was very little difference in the relative suppressiveness index between systems in both Study I and II, particularly when alfalfa was the test plant (Table 48). When wheat was the test plant, soil from the R-T system was more conducive to *Pythium* and the M-T system was more conducive to *Rhizoctonia*.

Table 48. Suppressiveness index of spring wheat soils in Study I and II.

	Relative suppressiveness index						
System	Alfalfa			Wheat			
Study I	Fus.	Rhizoc.	Pyth.	Fus.	Helm.	Rhizoc.	Pyth.
Conv.	1.08[a]	0.84	1.16	0.91	1.33	0.72	0.98
R-T	1.06	0.90	0.87	1.02	1.18	0.65	0.60
F-ratio	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	***
Study II							
Alt	0.80	1.02	0.87	1.07	1.45	0.93	0.80
Conv	0.94	0.93	1.05	1.00	1.73	0.93	0.86
M-T	0.91	0.98	0.76	1.20	1.48	0.65	0.76
F-ratio:	N.S.	N.S.	N.S.	N.S.	N.S.	**	N.S.

[a]Ratio of emergence in pathogen infested plot soil to that in pathogen infested conducive soil. Values greater than 1 indicate a pathogen-suppressive soil.
**Significant at .01 level
***Significant at .001 level

W.E.E.D. PROJECT DEMONSTRATIONS

L. J. Wrage, P. O. Johnson, D. A. Vos, and S. A. Wagner

Weed evaluation and extension demonstration plots provide data for northeastern South Dakota. The W.E.E.D. Project program includes demonstrations of labeled treatments in all major crops and experimental herbicides in corn, flax, alfalfa, edible beans, and potatoes.

Demonstration plots provide side-by-side comparison of herbicides. Rates used are those best suited for the weed and soil type. Plots are evaluated for weed control and crop tolerance. Yields are harvested from replicated tests. Data collected are summarized over several years to provide a more accurate measurement of expected performance. These plots are used for tours and form the basis for educational material.

Data for 1991 tests are reported. Evaluations for all major crops for the area are included. The station provides the only site for evaluating weed control in sunflowers, potatoes, and edible beans.

The crops included in 1991 are listed below:

1991 Evaluation/Demonstration Tests

1. Corn Herbicide Demonstration
2. Foxtail Removal Timing in Corn
3. Evaluation of Formulations of PPI Corn Treatments
4. Soybean Herbicide Demonstration
5. Evaluation of Russian Thistle Control in Soybeans
6. Evaluation of Foxtail Control in Spring Wheat
7. Flax Herbicide Demonstration
8. Sunflower Herbicide Demonstration
9. Edible Bean Herbicide Demonstration
10. Potato Herbicide Demonstration
11. Alfalfa Demonstration

Experimental Herbicide Evaluation Tests

Evaluation of Acetochlor Performance in Corn
Evaluation of Experimental Grass and Broadleaf Herbicide Combinations for Postemergence Weed Control in Soybeans
Postemergence Herbicides for Grass and Broadleaf Weed Control in Alfalfa
Fallow Weed Control

Performance in 1991 reflects weather conditions. Late season precipitation extended weed flushes and increased late weed growth. Plot information and weather data are summarized for each test. Weed control is reported as a visual evaluation compared to an untreated check. Crop effects are reported as VCRR (Visual Crop Response Rating) when differences are noted.

The cooperation and assistance from station personnel is acknowledged. Extension agents identify needs, assist with tours, and utilize the data in producer programs.

Data reported in this publication are results from field tests that include labeled product uses, experimental products or experimental rates, combinations or other unlabeled uses for herbicide products. Users are responsible for applying herbicides according to label directions. Refer to the appropriate weed control fact sheet available from county extension offices for herbicide recommendations.

Table 1. Corn Herbicide Demonstration

Planting Date: 5/8/91
PPI&PRE: 5/8/91
POST: 6/6/91
LPOS: 6/13/91
Soil: Silty clay loam; 3.2% OM; 6.3 pH

Precipitation: 1st week 0.02 inches
2nd week 0.25 inches

Weeds: Grft = Green Foxtail
Rrpw = Redroot Pigweed

Comments: Moderate weed pressure. Lack of rainfall after application reduced performance for preemergence treatments. No treatment provided 90% control of both grasses and broadleaves. Soil temperature was 50 degrees F. at application. Evaluation based on uncultivated plots.

Treatment	lb/A act.	% Grft 7/8/91	% Rrpw 7/8/91	3 Yr Avg. Gr	3 Yr Avg. Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eradicane	4	86	58	75	41
Eradicane+atrazine	4+1	91	83	88	80
Eradicane+Bladex	4+2	90	70	82	71
Eradicane+atrazine+Bladex	4+.5+1.5	93	88	88	89
Sutan+	4	83	49	82	33
SHALLOW PREPLANT INCORPORATED					
Dual	2.5	81	67	74	34
Lasso	3	79	77	72	64
SHALLOW PREPLANT INCORPORATED & POSTEMERGENCE					
Bladex&Accent+COC	2&.0313+.75 qt	81	78	--	--
PREEMERGENCE					
Atrazine	2.5	79	98	59	85
Bladex	3	84	86	59	84
Dual	2.5	90	61	69	40
Check	--	0	0	0	0
Lasso	2	81	57	64	45
Prowl	1.5	72	73	69	58
Ramrod	6	80	62	80	47
Lasso	3	85	63	72	51
Mon 8422 MT	2.25	90	75	--	--
ICI A5676	2.25	90	78	--	--
Acetochlor	2.25	--	--	87	61
Lasso+atrazine	2+1	81	89	72	88
Lasso+atrazine+Banvel	2+1+.5	84	92	--	--
Lasso+Bladex	2+2	89	85	80	80
Dual+atrazine	2+1	82	74	70	70
Dual+Bladex	2+2	88	65	70	75
Atrazine+Bladex	.75+2.25	76	92	59	89
Ramrod+Bladex	4+2	79	84	79	87
Lasso+Bladex+atrazine	2+1.5+.5	82	81	71	84
Dual+Bladex+atrazine	2+1.5+.5	78	63	--	--
ICI A5676+Bladex+atrazine	2+1.5+.5	85	77	--	--

Table 1. Continued

Treatment	lb/A act.	% Grft 7/8/91	% Rrpw 7/8/91	3 Yr Avg. Gr	3 Yr Avg. Bdlf
EARLY POSTEMERGENCE					
Prowl+atrazine	1.5+1	53	93	60	93
Prowl+Bladex	1.5+1.5	68	84	76	88
Atrazine+COC	1.5+1 qt	67	95	51	95
Bladex+X-77	2+.5%	77	51	61	75
PREEMERGENCE & EARLY POSTEMERGENCE					
Ramrod&Tough+atrazine	4&.45+.6	87	83	81	88
Ramrod&Banvel+Bladex	4&.25+1.5	88	93	--	--
Ramrod&Banvel	4&.5	85	96	67	96
PREEMERGENCE & POSTEMERGENCE					
Ramrod&Banvel	4&.25	69	92	55	94
Ramrod&2,4-D amine	4&.5	74	43	61	69
Ramrod&Basagran+atrazine+COC	4&.52+.52+1 qt	78	96	68	96
Ramrod&Buctril+atrazine	4&.25+.5	81	95	64	94
Ramrod&Banvel+atrazine	4&.25+.5	81	96	64	93
POSTEMERGENCE					
Accent+X-77	.0157+.25%	80	97	--	--
LSD (.05)				20.9	22.1

Table 2. Foxtail Removal Timing in Corn

Planting Date: 5/8/91
PPI&PRE: 5/8/91
POST: 6/6/91
LPOS: 6/13/91
VLPOS: 6/18/91
Soil: Silty clay loam; 3.9% OM; 6.0 pH

Precipitation: 1st week 0.02 inches
2nd week 0.25 inches

Weeds: Yeft = Yellow Foxtail

Comments: Purpose to evaluate the effect of time of foxtail removal on corn yield. Herbicide systems are compared. Initial yellow foxtail control was high with early Accent; late season grasses emerged after application. Yield was highest with preplant, preemergence and earliest Accent treatment.

Treatment	lb/A act.	% Yeft 21 DAT	% VCRR 21 DAT	% Yeft 8/19	Yield bu/A
Check	----	0	0	0	51.7
PREPLANT INCORPORATED					
Eradicane	4	89	0	65	152.1
PREEMERGENCE					
Dual	2.5	91	0	74	150.3
EARLY POSTEMERGENCE					
Accent+COC+28% N	.0312+.75 qt+ 3 qt	92	0	68	167.4
POSTEMERGENCE					
Accent+COC+28% N	.0312+.75 qt+ 3 qt	84	0	75	147.6
LATE POSTEMERGENCE					
Accent+COC+28% N	.0312+.75 qt+ 3 qt	77	0	80	126.2
VERY LATE POSTEMERGENCE					
Accent+COC+28% N	.0312+.75 qt+ 3 qt	74	0	86	120.7
LSD (.05)		4	0	4	17.2

Table 3. Evaluation of Formulations of PPI Corn Treatments

Planting Date: 5/8/91
PPI&PRE: 5/8/91
Soil: Silty clay loam; 4.7% OM; 6.6 pH

Precipitation: 1st week 0.02 inches
2nd week 0.25 inches

Weeds: Yeft = Yellow Foxtail
Ruth = Russian Thistle

Comments: Purpose to evaluate Eradicane formulations. Early-season foxtail control excellent with all treatments. Russian thistle control was less satisfactory and diminished as the season progressed. Light foxtail pressure developed by mid-August. Experimental ICIA5676 was equally effective. Yields reflect heavy weed competition. No cultivation.

Treatment	lb/A act.	% Yeft 6/6	% Ruth 6/6	% VCRR 6/6	% Yeft 8/19	% Ruth 8/19	Yield bu/A
Check	----	0	0	0	0	0	50.1
PREPLANT INCORPORATED							
Eradicane 25G	4	95	76	0	83	35	128.6
Eradicane 25G	5	96	79	0	86	41	127.4
Eradicane 6.7L	4	95	73	0	82	44	113.6
Eradicane 6.7L	5	97	77	0	84	45	128.4
PREEMERGENCE							
ICIA5676 6.4L	2	94	66	0	87	44	114.9
ICIA5676 6.4L	2.5	94	76	0	93	60	137.5
	LSD (.05)	3	19	0	5	18	20.4

Table 4. Soybean Herbicide Demonstration

Planting Date: 5/17/91
PPI&PRE: 6/14/91
POST: 6/14/91
Soil: Silty clay loam; 3.9% OM; 6.0 pH

Precipitation: 1st week 0.55 inches
2nd week 1.77 inches

Weeds: Yeft = Yellow Foxtail
Ruth = Russian Thistle

Comments: Excellent performance comparison. Uniform, moderate weed pressure. Performance in 1991 was similar to long-term average. Preemergence performance enhanced by adequate rainfall after application. Eight treatments exceeded 90% control for grass and broadleaves. No cultivation.

Treatment	lb/A act.	Percent Control 1991 % Yeft 7/8/91	% Ruth 7/8/91	3 Yr Avg Gr	Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Tri-4	.75	91	78	--	--
Trillin	.75	91	83	--	--
Trific	.75	89	80	--	--
Treflan	.75	89	82	89	85
Treflan	1	95	84	--	--
Pursuit	.75	81	96	--	--
Sonalan	1	95	93	90	89
Prowl	1.25	88	48	86	71
Treflan+Sen/Lex	.75+.38	87	79	87	87
Treflan+Command	.75+.75	88	94	--	--
Treflan+Pursuit	.75+.063	92	89	94	94
Treflan+Scepter	.75+.125	91	93	94	96
Prowl+Pursuit	.875+.063	91	92	94	96
Prowl+Pursuit	1.25+.032	86	82	--	--
SHALLOW PREPLANT INCORPORATED					
Lasso	3	85	43	83	75
Dual	2.5	88	44	79	56
Lasso+Treflan	2+.25	84	58	74	69
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan+Sen/Lex&Sen/Lex	.75+.25&.38	93	91	94	96
Treflan&Sen/Lex	.75&.5	91	84	94	93
PREEMERGENCE					
Lasso	3	93	41	81	53
Dual	2.5	94	53	75	51
Pursuit	.063	87	96	89	83
Lasso+Sen/Lex	2+.5	96	98	78	86
Dual+Sen/Lex	2+.5	94	93	76	85
Lasso+Pursuit	2+.063	97	92	92	82
Lasso+Lorox	2+1	88	47	77	58

Table 4. Continued

Treatment	lb/A act.	Percent Control 1991 % Yeft 7/8/91	Percent Control 1991 % Ruth 7/8/91	3 Yr Avg Gr	3 Yr Avg Bdlf
PREEMERGENCE & POSTEMERGENCE					
Lasso&Pursuit+X-77	2&.063+.25%	98	79	97	85
Lasso&Scepter+X-77	2&.063+.5%	97	67	--	--
Lasso&Basagran+COC	2&1+1 qt	83	77	73	89
Lasso&Blazer+X-77	2&.5+.5%	91	93	78	82
Lasso&Cobra+X-77	2&.2+.125%	81	95	70	93
Lasso&Blazer+ Basagran+X-77	2&.38+.25+.5%	87	81	67	90
Lasso&Pinnacle+X-77	2&.0039+.25%	84	88	71	95
Lasso&Classic+X-77	2&.0117+.25%	92	73	68	73
Lasso&Pinnacle+ Classic+X-77	2&.0039+ .0039+.25%	87	90	73	95
Lasso&Basagran+ Pinnacle+X-77	2&.5+ .0039+.25%	85	83	--	--
POSTEMERGENCE					
Fusilade+COC	.187+1 qt	87	0	91	0
Poast+COC	.2+1 qt	94	0	95	0
Option+COC	.15+1 qt	96	0	89	0
Select+COC	.094+1 qt	92	0	--	--
Fusilade+Option+COC	.125+.063+1 qt	95	0	--	--
Assure+COC	.0875+1 qt	92	0	90	0
Pursuit+X-77+28% N	.063+.25%+1 qt	79	90	75	82
Poast+Blazer+Basagran+COC	.3+.25+.5+1 qt	92	81	89	82
Assure+Pinnacle+ Classic+X-77	.1125+.0039+ .0039+.25%	63	92	--	--
LSD (.05)				22	20

Table 5. Evaluation of Russian Thistle Control in Soybeans

Planting Date: 5/17/91
PPI&PRE: 5/17/91
EPOS: 6/18/91
POST: 7/3/91
Soil: Silty clay loam; 3.9% OM; 6.0 pH

Precipitation: 1st week 0.55 inches; 2nd week 1.77 inches

Weeds: Grft = Green Foxtail; Ruth = Russian Thistle; Wimu = Wild Mustard; Colq = Common Lambsquarter

Comments: Uniform weed pressure. Provides opportunity to evaluate herbicide combinations across four important annual weeds. Three treatments exceeded 90% control on all species. Reduced rates in combinations were equally effective. Yields reflect weed control.

Treatment	lb/A act.	Percent Control 1991 % Grft 7/17	% Ruth 7/17	% Wimu 7/17	% Colq 7/17	Yield bu/A
PREPLANT INCORPORATED						
Check	----	0	0	0	0	12.7
Treflan	1	79	44	0	67	31.5
Sonalan	1.1	79	57	0	84	25.8
Prowl	1.25	75	35	0	54	19.8
Prowl+Pursuit	.875+.063	95	92	99	97	35.5
Treflan+Pursuit	.75+.031	91	92	99	97	35.4
Sonalan+Pursuit	1.1+.031	89	93	99	97	38.1
XRM-5313	1.03	79	90	99	87	34.5
Treflan+Sen/Lex	.75+.38	70	58	92	91	29.8
PREEMERGENCE						
Lasso+Pursuit	2+.063	96	87	98	96	37.3
Lasso+Sen/Lex	2+.5	85	73	99	95	31.9
PREEMERGENCE & EARLY POSTEMERGENCE						
Dual&Pursuit+ X-77+28% N	2&.063+ .25%+3 qt	96	34	92	36	34.5
Dual&Pursuit+ X-77+28% N	2&.031+ .25%+3 qt	97	43	98	52	36.5
Dual&Cobra+X-77	2&.2+.25%	87	90	97	16	29.3
Dual&Blazer+ Basagran+X-77	2&.25+.5+.5%	86	81	95	85	30.3
Dual&Pinnacle+X-77	2&.0039+.125%	81	92	80	73	35.5
Dual&Pinnacle+ Classic+X-77	2&.0039+ .0026+.125%	84	92	99	72	36.1
Dual&Classic+X-77	2&.0117+.125%	89	52	99	38	32.4
EARLY POSTEMERGENCE						
Pursuit+X-77+28% N	.063+.25%+3 qt	91	86	99	81	40.2
PREEMERGENCE & EARLY POSTEMERGENCE						
Dual&Pursuit+ X-77+28% N	2&.063+ .25%+3 qt	96	75	99	69	36.8
Dual&Cobra+ Pursuit+COC	2&.1+ .031+1 pt	96	85	99	37	33.2
PREEMERGENCE & POSTEMERGENCE						
Dual&Pinnacle+ Classic+X-77	2&.0039+ .0026+.125%	91	44	87	65	32.0
Dual&Pursuit+ X-77+28% N	2&.063+ .25%+3 qt	95	21	90	43	25.3
LSD (.05)		6	19	8	23	5.8

Table 6. Evaluation of Foxtail Control in Spring Wheat

Planting Date: 4/19/91
FALL: 11/1/90
2-4 LEAF: 5/30/91
TILLER: 6/6/91
Soil: Silty clay loam; 3.2% OM; 6.3 pH

Precipitation: POPI: 1st wk 0.00 inches
2nd wk 1.51 inches
2-4 LF: 1st wk 1.39 inches
2nd wk 0.09 inches
TILL: 1st wk 0.09 inches
2nd wk 0.65 inches

Weeds: Grft = Green Foxtail
Wioa = Wild Oat

Comments: Excellent weed control and crop response evaluation. Several treatments provided very good control of both foxtail and wild oat. Crop yields were increased 5 bu/A for effective treatments. Tiller 50 applied at late stage produced visual crop response and reduced yield.

		Percent Weed Control 1991				3 Year Average		
Treatment	lb/A act.	% Grft 7/17	% Wioa 7/17	% VCRR 7/17	Yield bu/A	% Grft	% Wioa	Yield bu/A
FALL								
Check	----	0	0	0	15.3	0	0	14.7
Treflan 4L	.75	80	35	6	25.8	81	50	27.3
Treflan 10G	.75	69	44	30	15.0	79	50	19.9
Far-go 10G	1.25	5	75	0	20.9	20	69	27.2
Far-go 4L	1.25	0	55	0	20.6	--	--	----
POSTPLANT INCORPORATED								
Treflan 4L	.75	85	16	15	17.1	86	26	20.8
Far-go 4L	1.25	0	58	0	18.1	8	52	24.2
2-4 LEAF								
Hoelon+COC	.75+1 pt	94	94	0	21.8	90	95	28.9
Hoelon	1	95	93	0	21.5	92	95	28.9
TILLER STAGE								
Hoelon+COC	.75+1 pt	85	57	0	19.5	88	71	21.8
2-4 LEAF								
Tiller 50	.42	91	89	0	20.3	--	--	----
Tiller 50+Banvel	.42+.063	88	85	0	22.7	--	--	----
Tiller	.39	91	81	0	19.0	93	89	29.0
Tiller 50	.35	87	85	0	20.0	--	--	----
TILLER STAGE								
Tiller 50	.35	95	83	24	11.7	--	--	----
2-4 LEAF								
Puma	.08	95	97	0	20.9	92	95	27.3
Assert	.38	0	71	0	18.3	20	81	26.7
TILLER STAGE								
Avenge	1	0	82	0	14.6	--	--	----
2-4 LEAF								
Dakota	.58	90	81	0	18.9	--	--	----
Cheyenne+ Harmony Extra	.46+.014	94	95	0	20.5	--	--	----
	LSD (.05)	7	7	6	4.3	13	8	3.7

Table 7. Flax Herbicide Demonstration

Planting Date: 5/17/91
PPI&PRE: 5/17/91
POST: 6/14/91
Soil: Silty clam loam;
3.9% OM; 6.0 pH

Precipitation: 1st week 0.55 inches
2nd week 1.77 inches

Weeds: Grft = Green Foxtail
Rrpw = Redroot Pigweed

Comments: Flax was five inches at postemergence. Heavy foxtail pressure. Foxtail control was excellent for several treatments. Foxtail control was the primary factor influencing yield.

Treatment	lb/A act.	Percent Weed Control 1991 % Grft 7/8	% Rrpw 7/8	Yield bu/A	2 Year Average Grft	Bdlf	Yield bu/A
PREPLANT INCORPORATED							
Check	----	0	0	5.9	0	0	9.6
Treflan	.5	91	87	12.0	92	64	17.9
PREEMERGENCE							
Ramrod	4	92	55	10.3	90	28	14.0
POSTEMERGENCE							
MCPA amine	.5	0	86	4.5	0	68	7.7
MCPA ester	.5	0	85	4.7	0	73	9.1
Buctril	.25	0	93	6.9	0	94	11.8
MCPA ester+Tordon	.5+.0156	0	91	4.6	0	73	2.6
Poast+COC	.2+1 qt	97	0	9.9	96	0	13.2
Poast+Buctril+COC	.2+.25+1 qt	97	84	10.8	96	89	15.5
Poast+Buctril	.2+.25	89	88	8.8	--	--	----
Basagran+MCPA amine+ Poast+Dash	.5+.13+ .15+1 qt	95	83	10.1	--	--	----
Basagran+MCPA amine+ Poast+Dash	.75+.25+ .15+1 qt	97	91	9.8	--	--	----
Basagran+Dash	.75+1 qt	0	83	5.5	--	--	----
Basagran+Buctril+Dash	.75+.25+1 qt	0	91	4.6	--	--	----
LSD (.05)		3	8	3.2	2	21	4.5

Table 8. Sunflower Herbicide Demonstration

Planting Date: 5/20/91
PPI&PRE: 5/20/91
POST: 6/14/91
LPOS: 6/18/91
Soil: Silty clay loam; 3.2% OM; 6.3 pH

Precipitation: 1st week 0.77 inches; 2nd week 2.12 inches

Weeds: Grft = Green Foxtail; Rrpw = Redroot Pigweed

Comments: Excellent performance for several treatments; experimental postemergence treatment show promise. Rate response for Treflan, Prowl incorporated was superior to preemergence. No crop response symptoms noted; further evaluation of crop tolerance to Blazer required. No cultivation.

Treatment	lb/A act.	Percent Weed Control: % Grft 7/8/91	% Rrpw 7/8/91	3 Year Average: % Grft	% Rrpw
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	3	95	23	86	58
Sonalan	1	90	90	91	92
Treflan	.5	81	73	74	80
Treflan	.75	88	80	86	86
Treflan	1	92	82	90	88
Prowl	1.25	89	68	82	78
SHALLOW PREPLANT INCORPORATED					
Lasso	3	79	68	70	71
Prowl	1.25	80	70	77	78
PREEMERGENCE					
Lasso	3	91	65	76	69
Prowl	1.25	63	65	66	73
POSTEMERGENCE					
Poast+Dash	.2+1 qt	98	0	96	0
Fusilade+COC	.187+1 qt	94	0	89	0
POSTEMERGENCE & LATE POSTEMERGENCE					
Blazer&Poast Plus+COC	.125&.2+1 qt	97	78	--	--
Blazer+X-77& Poast Plus+COC	.125+.125%& .2+1 qt	95	85	--	--
Blazer+28% N& Poast Plus+COC	.125+2 qt& .2+1 qt	96	87	--	--
Blazer+COC& Poast Plus+COC	.125+1 qt& .2+1 qt	97	78	--	--
POSTEMERGENCE					
Blazer+Poast Plus	.125+.2	95	84	--	--
LSD (.05)		5	15	12	14

Table 9. Edible Bean Herbicide Demonstration

Planting Date: 5/21/91
PPI&PRE: 5/21/91
POST: 6/14/91
Soil: Silty clay loam; 3.2% OM; 6.3 pH

Precipitation: 1st week 0.77 inches
2nd week 2.12 inches

Weeds: Grft = Green Foxtail
Ruth = Russian Thistle

Comments: Includes evaluation of several experimental herbicides for edible beans. Uniform, moderately heavy weed pressure. Tank-mix of Eptam + Treflan and Pursuit overlay treatment was consistent on grasses and broadleaves; experimental Blazer postemergence provided improved Russian thistle control. No significant crop response was noted; conditions favored crop tolerance.

		Percent Control 1991		3 Yr Avg.	
Treatment	lb/A act.	% Grft 7/8	% Ruth 7/8	Gr	Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	4	78	60	76	38
Treflan	.75	85	84	76	71
Sonalan	1.1	87	86	82	85
Prowl	1.5	84	80	81	56
Treflan+Command	.75+.5	81	88	--	--
Eptam+Treflan	4+.5	94	90	--	--
SHALLOW PREPLANT INCORPORATED					
Lasso	3	66	70	58	48
Dual	2.5	69	60	57	35
PREPLANT INCORPORATED & PREEMERGENCE					
Treflan&Pursuit	.75&.032	95	98	--	--
Treflan&Pursuit	.75&.047	97	98	--	--
Command&Pursuit	.5&.032	87	96	--	--
PREPLANT INCORPORATED & POSTEMERGENCE					
Treflan&Basagran+COC	.75&1+1 qt	75	80	77	90
Treflan&Blazer+X-77	.75&.5+.5%	94	92	--	--
POSTEMERGENCE					
Fusilade+COC	.187+1 qt	95	0	91	0
Poast+COC	.2+1 qt	97	0	95	0
Poast+Basagran+COC	.3+1+1 qt	95	60	92	79
Poast+Blazer+COC	.3+.38+1 qt	96	93	--	--
LSD (.05)				16	32

Table 10. Potato Herbicide Demonstration

Planting Date: 5/21/91
PPI, PRE, POPI: 5/20/91
POST: 6/18/91
Soil: Silty clay loam;
3.2% OM; 6.3 pH

Precipitation: 1st week 0.77 inches
2nd week 2.12 inches

Weeds: Yeft = Yellow Foxtail
Rrpw = Redroot Pigweed

Comments: Weed control in 1991 was somewhat greater than for long-term average. Eptam combinations and preemergence combinations with Dual were most consistent for foxtail control. Yield is direct response to level of weed control.

		Percent Weed Control 1991			3 Year Average		
Treatment	lb/A act.	% Yeft 7/8	% Rrpw 7/8	Yield Cwt/A	% Gr	% Bdlf	Yield Cwt/A
PREPLANT INCORPORATED							
Check	----	0	0	4.0	0	0	20.4
Eptam	4	83	25	35.5	75	44	51.3
Eptam+Sen/Lex	3+.5	90	84	81.2	78	84	69.0
Eptam+Sen/Lex	4+.75	90	86	96.6	82	90	84.5
POSTPLANT INCORPORATED							
Treflan	1	73	53	14.5	66	53	20.2
Prowl	1.25	74	69	25.2	67	58	25.8
PREEMERGENCE							
Dual	2.5	84	45	43.8	77	50	57.5
Dacthal	7.5	58	50	19.1	48	51	30.2
Dual+Sen/Lex	2+.75	89	92	106.8	88	83	94.0
Dual+Lorox	2+1	87	50	43.3	79	62	71.3
Prowl+Sen/Lex	1.25+.75	84	95	85.4	77	87	92.9
PREPLANT INCORPORATED & POSTEMERGENCE							
Eptam+Sen/Lex&Sen/Lex	3+.5&.5	97	98	107.8	88	97	91.1
POSTEMERGENCE							
Sen/Lex	1	84	92	97.9	62	92	67.2
Poast+Sen/Lex+Dash	.1+.25+1 qt	67	69	61.6	--	--	----
Poast+Sen/Lex+Dash	.2+.38+1 qt	67	87	66.2	68	89	87.8
Poast+Sen/Lex+Dash	2+.75+1 qt	75	86	62.5	--	--	----
Poast+Dash	.2+1 qt	95	0	40.1	--	--	----
PREPLANT INCORPORATED & POSTEMERGENCE							
Eptam&DPX-E9636	3&.0313	66	88	32.7	--	--	----
POSTEMERGENCE							
DPX-E9636	.0313	45	86	35.0	--	--	----
LSD (.05)		13	14	37.0	18	14	31.6

Table 11. Alfalfa Herbicide Demonstration

Planting Date: 4/19/91
PPI: 4/19/91
EPOS: 5/30/91
POST: 6/7/91
LPOS: 6/18/91
Soil: Silty clay loam; 3.2% OM; 6.3 pH

Precipitation: 1st week 0.00 inches
2nd week 1.51 inches

Weeds: Gr = Yellow Foxtail
Bdlf = Russian Thistle

Comments: Uniform weed pressure. Foxtail and Russian thistle effectiveness apparent for each treatment. Only two treatments exceeded 80% control of both species. Experimental treatments show promise for grass control. No visual crop response noted; conditions favored crop tolerance. Data for 1991 similar to long-term average.

Treatment	lb/A act.	Percent Weed Control % Gr 7/8/91	Percent Weed Control % Bdlf 7/8/91	3 Year Average % Gr	3 Year Average % Bdlf
PREPLANT INCORPORATED					
Check	----	0	0	0	0
Eptam	2.5	86	15	77	13
Balan	1.25	70	50	74	57
Treflan	.75	66	50	79	50
Prowl	1	69	33	75	28
POSTEMERGENCE					
Poast Plus+Dash	.2+1 pt	95	0	97	0
Fusilade+COC	.187+1 qt	94	0	--	--
Pantera+COC	.06+1 qt	95	15	--	--
Buctril+Poast Plus+Dash	.25+.2+1 qt	82	87	86	91
Pursuit+X-77	.063+.25%	86	63	88	75
Pursuit+Poast Plus+COC	.063+.15+1 qt	82	45	--	--
2,4-DB+Poast Plus+Dash	.75+.2+1 qt	91	78	--	--
POSTEMERGENCE & LATE POSTEMERGENCE					
Buctril&Poast Plus+Dash	.25&.2+1 pt	85	79	--	--
Buctril&Poast Plus+Dash	.38&.2+1 pt	89	92	--	--
EARLY POSTEMERGENCE					
Poast Plus+Dash+Oats	.2+1 qt	96	0	95	0
LSD (.05)		6	18	11	10